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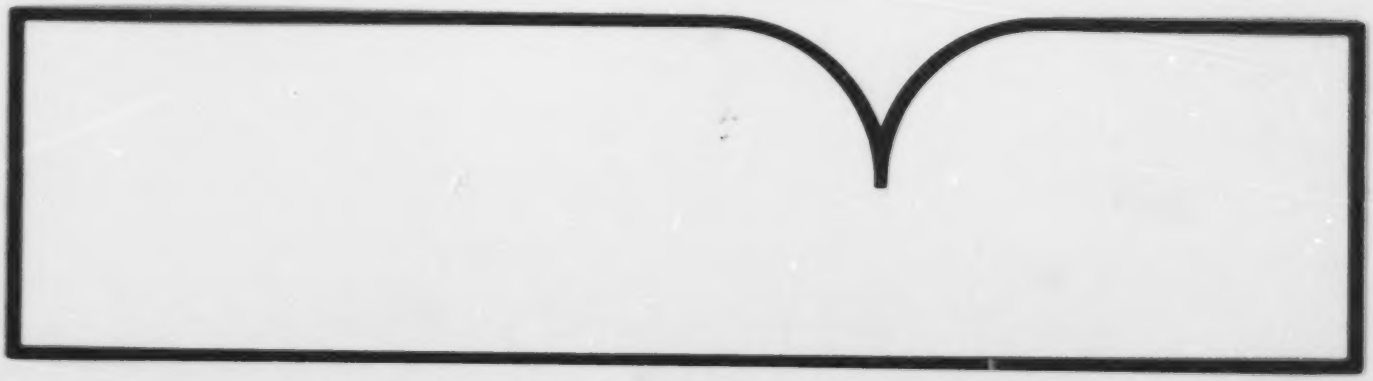

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Unfinished Business in New England: A Comparative Assessment of Environmental Problems

Overview Report

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This report presents the results of a study conducted by EPA in New England that examined 24 environmental problems and assessed the level of residual risk posed by each problem to human health and to ecosystems. Residual risk is defined as the risk posed by a problem, given current levels of control.The authors also estimated the management tools that are currently available to address the highest risk problem areas. The Overview Report of Unfinished Business in New England: A Comparative Assessment of Environmental Problems summarizes the methodology that was used to conduct these analyses, the findings of the study and lessons learned. Definitions of each problem area are included as well as a summary of the ranking for each problem area. The three problems posing the most serious residual risk for human health are ozone, radon and lead. The problems posing the most serious ecological risks are air pollution (primarily ozone), acid rain, loss of wetlands and habitat, all discharges to surface water and accidental releases.

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Overview Report

United States Environmental Protection Agency
Region I, Boston, Massachusetts

December 1988

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PREFACE
BY
MICHAEL R. DELAND

Friends of the Environment:

New England is renowned for its rich and varied environment. Our mission at EPA Region I is to protect and preserve both the health of our residents and visitors and the diversity and vigor of our natural environment. Unfinished Business in New England is an objective self-assessment of how we are meeting that challenge.

This report does two things. First, it summarizes current conditions in New England by bringing together "snapshots" of 24 environmental problems, both in terms of the risks they pose and how EPA is equipped to deal with them. Second, it marks the first step in our use of comparative risk evaluation: an innovative new approach to setting environmental priorities.

As environmentalists, we at EPA share our neighbors' concerns about the seemingly endless stream of contaminants and pollutants, chemicals and waste that threaten our health and assault our natural surroundings. Often at EPA we become frustrated because for every problem we begin to solve, many new problems appear. At the same time the Federal budget deficit is a reality that we must deal with for the foreseeable future. Comparative risk evaluation will help us direct our resources to those areas where they can do the most good, that is, where they can achieve the greatest reduction in risk. Moreover, it is a first step towards breaking down artificial bureaucratic delineations between air, water and land pollution problems.

At the start of this project more than a year ago, we asked the questions - "Which environmental problems pose the greatest risk to public health and to our ecosystems?" and "What management tools do we have to address the highest risk problem areas?" Unfinished Business in New England is our response to these questions and some of the answers are disturbing. They challenge our institutional complacency and suggest a need to reconsider how we use our resources.

For example, we are directing only limited attention to some of the highest risk environmental problems such as lead in soil and loss of wetlands and habitat. We have had only limited success in solving some of our most persistent problems such as smog. And in some cases, we are poorly equipped, either through lack of resources or legal authority, to address high risk problems such as indoor air pollution.

Our evolving understanding of the complexity of the environment demands that we reexamine our approach to solving environmental problems. Federal, state and local government must work together to find environmental solutions that manage risk while avoiding the trap of simply moving pollution around. It is with this goal in mind that we release Unfinished Business in New England.

This report and the debate it will engender will, I hope, make us better environmental managers and make our public better critics. We would be delighted to hear your reactions to this report.

Michael R. Deland
Regional Administrator

Transmittal Memo

This report was prepared by the Region I Comparative Risk Project (CRP). The Region I CRP is a collaborative effort between Region I of the U.S. Environmental Protection Agency (EPA) and the Office of Policy, Planning and Evaluation (OPPE) at EPA's Headquarters in Washington, D.C. EPA initiated the project as part of its pursuit of new approaches to environmental management and policy-making. The purpose of the CRP is to use risk information in an integrated approach to identify and assess environmental issues, to set priorities among these issues, and to develop appropriate approaches to manage these problems.

The Region I CRP is one of four CRPs begun in 1987 across the country (also in Region III, Region X, and Pennsylvania). Region I participated because Regional officials wanted to explore better ways to identify, assess, and manage the human health, ecological, and economic risks from environmental problems in the area. OPPE is sponsoring new CRPs in EPA Region IV and the states of Colorado, Vermont, and Washington.

The decision-making body of the Region I CRP consisted of a Steering Committee made up of senior staff from the Region and OPPE from Headquarters. Three technical work groups, consisting of professional staff from the Region, gathered and evaluated the risk information and developed the initial rankings of issues. OPPE provided administrative, technical, and analytical support.

For further information on the Region I CRP, contact Region I. For further information on other CRPs, please contact OPPE.

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Executive Summary

Newly "discovered" environmental problems or problems where past efforts are only partially successful pose the greatest risk to human health and the environment in New England. The technology to address most environment problems is generally available but it will be very expensive to implement. At this time, Region I does not have the resources or in some cases the legal authority to be successful in solving these problems. While the public is very concerned about environmental issues, most people focus their attention on a few problems that affect a relatively small number of people while problems that have a serious impact on millions go unnoticed.

These are the major findings of Phase I of Region I's *Unfinished Business in New England: A Comparative Assessment of Environmental Problems*. They are consistent with the findings of the national report *Unfinished Business* and with similar pilot projects in Regions III and X. The challenge to environmental managers in New England and elsewhere is to focus their limited resources on strategies that have the greatest potential for risk reduction.

The balance of this summary includes sections on the major results of the project, important lessons learned in the implementation of the project, and a brief discussion of the methodology.

Major Results

The major results from the project are the rankings of the 24 problem areas for human health and ecological risk, and an evaluation of five risk management factors for each problem area. Since the intent of the project was the identification of areas of unfinished business, we assessed residual risks, i.e., the uncontrolled portion of environmental problems. Risks that are currently abated were not considered. We found the following:

- The problem areas that rank highest for human health risk include criteria air pollutants (ozone), lead, and radon.
- The highest ranking ecological risks are criteria air pollutants (ozone), acid deposition, all discharges to surface waters, habitat loss, and accidental releases.
- Waste problem areas pose low residual public health risks and medium ecological risks and may pose high welfare risks. This is a problem area that is perceived by the public as posing a high level of risk.
- Ground water is an important environmental resource for the New England Region. Although the current residual risks to public health and ecological receptors are relatively low, ground water is a vital resource that must be protected for future generations.

The rankings by risk do not correspond closely with Region I's current program priorities. Areas of relatively high risk but low Region I effort include indoor radon, lead, indoor air pollution, acid deposition, industrial and nonpoint source discharges to surface waters, and drinking water. Areas of high Region I effort but relatively medium or low risks include Superfund waste sites and underground storage tanks.

This divergence between what we found in terms of relative risks and Region I's priorities is not necessarily inappropriate. Some problems appear to pose relatively low risks precisely because high levels of program effort have been devoted to controlling them. And these high levels of attention may remain necessary in order to hold risks to current levels.

Overall, Region I's priorities reflect EPA's national priorities and appear more closely aligned with public opinion than with our estimated risks.

General Lessons

- **Interpretation and utilization of results must be done with caution.** Evaluation of residual risks only may miss important aspects of environmental problems such as use and source trends and the beneficial impact of ongoing base programs. Also, problem areas as defined in this report may be difficult to compare with standard EPA programs (e.g., the exclusion of radon and lead from the drinking-water problem area).

- **Regional data are often inaccessible.** EPA and state agencies should put more effort into developing and improving data management systems.

- **High-ranking public health problems in general differ from high ranking ecological problems.** Ozone is the exception to this because it poses high residual risks to environmental receptors and humans.

- **Rankings based solely on residual risk given present exposure patterns may underestimate the importance of ground water as an environmental resource.** This resource is clearly being affected and could pose higher risks in the future if alternative water supplies are not available and if contaminant discharges to sensitive receptors are not controlled.

- **The effectiveness of ongoing base programs has a great impact on the relative ranking results.** Problems ranking low may do so because a large part of the problem is being controlled successfully.

- **Risk Management Work Group results are the key elements linking the ecological and public health rankings to the Region I planning process.** The risk management results summarize factors that influence the ability to control these various environmental problems.

- **Institutional barriers made it difficult to conduct this analysis in an objective fashion and may affect the use of its results.** The compartmentalization of environmental problems has created a difficult climate for analyzing or resolving complex multimedia issues at EPA.

- **The Risk Reduction Project is a first step toward developing a more analytical approach to planning and priority setting in Region I.** Historically, many planning decisions have been based on the professional judgment of senior agency managers. We now have an analytical tool requiring data collection and analysis and the use of best professional judgment. The analytical tool can be used in an ongoing way to help us compare environmental problems.

Methodology

The method we used to compare environmental problem areas can best be described as systematically generating informed judgments among Agency experts. The 35 people involved in the project represented different environmental programs and scientific expertise. We divided into three work groups, focusing on the public health risks, the ecological risks, and the risk management factors. Existing data on pollutants, exposures, and effects were assembled and analyzed, but ultimately we had to rely on our professional judgment to fill the substantial data gaps. In this sense, the project represents expert opinion rather than quantitative analysis. Despite the difficulties caused by lack of data and lack of accepted risk assessment methods in some areas, the participants felt relatively confident in their final rankings.

The regional staff analyzed problem areas defined to correspond with existing EPA programs or statutes. We excluded certain problem areas that were felt to be beyond the scope of EPA Region I, such as stratospheric ozone depletion and CO_2 and global warming, and added problems of particular interest to New England such as lead. The final list consisted of 24 problems that were analyzed for this report.

For each problem area, two different types of risk were assessed: public health risks, which included cancer and non-cancer risks; and ecological risks. We also analyzed risk management factors, including public perception, available resources, legal authority, available technology, and economic impact. Each type of risk was evaluated separately. We did not judge whether one type of risk was more important than another, and we made no attempt to add risks for a problem across the risk types.

I. Introduction

Comparative risk evaluation is a powerful analytical tool that can be used to identify areas of environmental concern. We define comparative risk evaluation as an analytical process that utilizes data and professional judgment to compare environmental problems. *Unfinished Business in New England: A Comparative Assessment of Environmental Problems* represents the completion of Phase I of the Risk Reduction Project (RRP). It is a comparative risk evaluation of 24 different environmental problems in New England. This project has been a major effort in Fiscal Year 1988, involving the significant time and effort of approximately 35 people at EPA Region I. Knowledgeable staff have examined data on sources, pollutants, ambient concentrations, and receptors (humans and ecosystems) to determine a relative ranking of environmental problems. Risk management issues have also been considered for each problem area. The RRP is designed to provide improved planning information for environmental managers. It is not meant to provide state-of-the-art quantitative risk assessment information for each problem area and should not be used as such.

The methodology and results presented in this *Overview Report* represent Phase I of this effort and will be used to support planning and priority setting in the Region. The agenda for Phase II, currently under development, may include refining Phase I results by doing a more detailed evaluation within problem areas, addressing data gaps identified in Phase I, or other types of initiatives not yet specified.

After briefly discussing the background and objectives of the RRP, this report describes the study methodology used and summarizes the results. The three Work Group Reports discuss each analysis and the results in more detail.

Background

In February 1987, the U.S. EPA Headquarters Office of Policy Analysis released the results of a study entitled *Unfinished Business: A Comparative Assessment of Environmental Problems*. This study, referred to as the National Comparative Risk Project (NCRP), was an evaluation of 31 environmental problems to determine the health, ecological, and welfare risks they posed, given current levels of control. More than 75 senior scientists and managers participated in this effort over a period of nine months. Reviewers commended this study as an attempt by EPA to be self-critical, that is, to reflect on the workings of the agency as a whole to determine if the current priorities of EPA were appropriate to an agency whose mission is to protect public health and the environment. In many cases, the NCRP risk rankings did not correspond well with EPA's current program priorities. For example, indoor radon ranked high as a health risk but receives few resources, whereas the Superfund program ranked relatively low but is a high EPA priority and receives large amounts of resources. This divergence may be appropriate as some programs may rank low because a high level of effort

has been put into controlling them in recent years. The report highlighted serious health and environmental problems that are not being well controlled by EPA, and provided much food for thought for individuals inside and outside the federal government.

Following the release of the NCRP Report, three of the EPA Regional Offices (Regions I, III, and X) agreed to conduct similar analyses. The national study had relied on national data and expert professional judgment to determine the rankings. We believed that an analysis done on a smaller scale using regional data could help to calibrate the national study results, as well as to provide a mechanism to improve the regional planning process. The Region I comparative risk study, the RRP, began in May 1987.

Objectives

The Risk Reduction Project had two explicit goals at its outset:

- Develop a methodology for comparative risk evaluation to assist EPA and state managers in effectively integrating information about health and environmental risk into the Region I priority-setting process. This methodology should be usable in an ongoing way and will build on previous planning work.

- Use this methodology to rank a series of environmental problems to provide regional managers with an evaluation of the health and environmental problems posing the highest residual risks in New England. These results are to be used to help determine FY89 program grant, resource, and accountability system commitments.

We identified two other important goals of the Risk Reduction Project as the process evolved:

- Identify significant data gaps. Many data gaps remained even when doing this analysis at the regional level. These gaps made it difficult or impossible to rank certain problem areas.

- Educate EPA, state staff, and the public about the RRP and its results. The NCRP found that EPA's current priorities match fairly closely with public perception of health and environmental risks. In order for EPA to shift priorities in coming years, it will be crucial to educate both environmental decision makers and the public about the significance of existing and newly recognized environmental problems.

II. Structure of Analyses

Types of Analyses and Project Structure

Three work groups conducted the comparative risk evaluation. The Public Health Risk Work Group evaluated the public health risks of a series of environmental problems, considering both cancer and non-cancer effects. The Ecological Risk Work Group evaluated ecological risks posed by the same set of problems. The Risk Management Work Group evaluated public perception, available resources, economic impact, effective technology, and legal authority as the risk management factors affecting the Agency's ability to control these problems. A Branch Chief chaired each work group of approximately 10 people. Division Directors assigned staff members representing different environmental programs and scientific expertise to each work group.

We also formed a Risk Reduction Project Steering Committee, composed of EPA Region I senior staff, an EPA Headquarters representative, a state environmental manager, and a representative of the Region's interstate groups. The Steering Committee provided overall policy guidance and direction for the project. A project manager coordinated the efforts of the three work groups and served as a liaison to the Steering Committee. The work groups, formed during the summer of 1987, met on a monthly, semimonthly, or weekly basis over a period of approximately nine months to conduct the analysis. Region I had contractor assistance to conduct the evaluation, primarily from Temple, Barker & Sloane, Inc. (TBS) of Lexington, Massachusetts.

Problem Area Definitions

The first major task of the work groups was to agree on a list of environmental problems for analysis. The starting point for this discussion was the list of 31 problems evaluated by the NCRP. The NCRP task force developed its list by considering all major environmental programs in which EPA is involved. The NCRP list is not defined exclusively by sources, pathways, or receptors, but rather is a mixture of these. The Headquarters study team chose to divide the environmental pie in this way to reflect both how EPA is organized, and also how they believed people categorize environmental problems. The regional staff expressed some concern with the inconsistency of the problem definitions because we believed it could pose difficulties in the analysis. We finally agreed to use a list similar to that developed by Headquarters in order to facilitate comparisons with the NCRP and the other two regional comparative risk studies.

The work groups modified the NCRP list from 31 to 24 problems (Table 1). We omitted problems such as stratospheric ozone depletion, CO_2 and global warming, biotechnology, and new toxic chemicals that were considered to be problems on a national and international scale, rather than regionally focused. We believe that stratospheric ozone depletion and increased CO_2 levels resulting in global warming are extremely serious environmental problems. The NCRP ranked these two problems as posing the greatest ecological threats nationally.

Table 1

Environmental Problem Areas

(not in rank order)

Reference Number		Reference Number	
1.	Criteria Air Pollutants	11.	Wetlands/Habitat Loss
2.	Acid Deposition and Visibility	12.	Drinking Water
3.	Hazardous/Toxic Air Pollutants	13.	RCRA Waste Sites
4.	Radon	14.	Superfund Waste Sites
5.	Indoor Air Pollutants Other than Radon	15.	Municipal Waste Sites
6.	Radiation from Sources Other than Radon (non-ionizing)	16.	Industrial Waste Sites
7.	Industrial Point Source Discharges to Surface Waters	17.	Accidental Releases
8.	POTW Discharges to Surface Waters	18.	Releases from Storage Tanks
9.	Nonpoint Source Discharges to Surface Waters	19.	Other Ground-Water Contamination
10.	Discharges to Estuaries, Coastal Waters, and Oceans from All Sources	20.	Pesticide Residues on Food
		21.	Pesticide Application
		22.	Lead
		23.	Asbestos
		24.	Lakes, Ponds, and Impoundments

We added several problem areas to the regional list for analysis, as follows:

- Lead exposure from all sources. The exposure is recognized as a significant public health problem in New England.
- Asbestos exposure from all sources. Region I has an ongoing asbestos control program that receives resources, and we believed it would be valuable to evaluate this pollutant on its own.
- Lakes, Ponds, and Impoundments. We added this problem area at the request of a New England state.

Ground Rules for the Analyses

After developing a regional list of problem areas, the work groups formulated several ground rules to be followed in the analyses.

Residual Risk. One of the most significant ground rules concerns the issue of residual risk. The problems were analyzed considering the current level of control, that is, only the uncontrolled portion--the **residual risk**--was evaluated. This type of analysis provides decision makers with information on existing risks that is important for future resource allocation. Several issues emerged in doing this type of analysis. First, it was difficult to define residual risk consistently for all problem areas. Sometimes the existing control was a temporary rather than permanent control, such as the provision of bottled water or a ban on fishing. The work groups agreed that exposures could occur with temporary controls and therefore did evaluate these exposures. For example, when evaluating waste sites, we assumed that trespassing could occur even if a site was fenced; we also assumed that exposure to contaminated ground water could occur, even if bottled water were provided, until the contamination was cleaned up. Second, when evaluating only residual risks, programs that have been successful will fall to the bottom of the list. It may be misleading to assume that resources can be removed from these programs, because the current level of resources may be needed to maintain this low level of residual risk. It is important to be mindful of this consideration when reviewing the results of our analysis.

Quantitative and Qualitative Analyses. Work group members agreed to gather data to assist in providing some perspective on the relative health or environmental risks posed by each problem area. We agreed to do a quantitative analysis where there were sufficient data and an appropriate methodology (such as in calculating cancer risks). The work groups also understood that much of the analysis would be qualitative because of both data and methodology limitations. In these cases, the groups would reach consensus after detailed discussion of each problem area and the use of best professional judgment by each member.

Data Gathered. We agreed to use existing data rather than collect new data for the analyses. Where available and appropriate, we evaluated monitoring data from the previous year (1987); otherwise we used the most current year of data available.

Exposure Estimates. In determining exposure concentrations from monitoring or modeling data, we used typical or average concentrations rather than maximum concentrations. Therefore, we evaluated the exposure scenario associated with the typical or average situation rather than a worst-case scenario.

Time Period for Measuring Effects/Discounting. We evaluated present and future health and environmental effects caused by current emissions. For example, cancer cases resulting from current exposures, which may not appear for 20 years because of a latency period, were included in this analysis and were not discounted.

Uncertainty. For each problem area evaluated, we determined whether the uncertainty was high, medium, or low. The level of uncertainty was determined by the group after discussing the problem area. A high uncertainty usually did not cause a problem to be ranked lower, but did highlight the possibility of significant data gaps.

Percentage of Problem Covered. For the public health and ecological risk evaluations, we also determined whether the percentage of problem covered was high, medium, or low. For some problem areas, it was fairly easy to extrapolate from limited data to the entire problem area. For others, we felt that the evaluation included only a small portion of the problem area.

Identification of Sources. Some members of the Steering Committee expressed interest in understanding the structure of risk for each problem area, i.e., what are the most important sources, pathways, and stressors? Although the analysis did not provide a comparative risk evaluation within each problem area, we did identify, where possible, the sources of greatest concern.

Summary of Work Group Approaches

The Ecological and Public Health Risk Work Groups followed the same general approach. Members of these work groups were designated as problem area leads according to individual areas of expertise. To develop the methodology for determining residual risk, both groups reviewed the methodologies described in the appendices of the NCRP and modified them for regional use. Work group members then prepared plans of analysis, which were proposed plans for how each problem should be analyzed to determine the residual risk it posed. EPA Headquarters staff and consultants prepared several plans of analysis to assist in developing regional plans. All plans were presented to the group for discussion and critique. Following discussion of the plans, we gave our contractor direction regarding data to be collected and analyzed. Work group members worked directly with the consultants to see that appropriate information was gathered for their problem areas. Work group members then presented the results of their quantitative or qualitative analyses to the group, and the group determined the relative ranking of the problem.

The Risk Management Work Group required a different approach because of the nature of the analysis and the lack of a Headquarters model.

The following sections summarize the specific approaches of each work group. The reader is referred to the individual Work Group Reports for a detailed discussion of each work group analysis.

Public Health Risk Work Group

Unlike the NCRP, which had separate work groups for the evaluation of cancer and non-cancer effects, the Public Health Risk Work Group was charged with evaluating all public health risks. The work group approached the analyses by evaluating cancer and non-cancer effects separately and then combining the lists at the end of the analyses. For each problem area, work group members evaluated the risk to an individual potentially exposed to estimated concentrations. The work group also estimated the potentially exposed population in Region I and developed population risk estimates where possible. This allowed the work group to consider both individual and population risk in developing the ranking.

General and Cancer Methodology

The methodology used by the Public Health Risk Work Group was derived from the NCRP. Work group members reviewed the NCRP appendices for cancer and non-cancer analyses and made minor modifications to the approaches presented.

In our analyses we were able to follow roughly the standard components of risk assessment: toxicity assessment (which includes hazard identification and dose-response assessment), exposure assessment, and risk characterization.

Toxicity Assessment. We first identified a short list of chemicals associated with and representative of each problem area. We then determined whether these chemicals posed carcinogenic and/or non-carcinogenic risks and whether acute and/or chronic effects were of concern. For the dose-response assessment, we determined the potency of each chemical, using the cancer potency factors derived by the Carcinogen Assessment Group (CAG) in EPA Headquarters for carcinogens and the NCRP approach to potency and severity for non-carcinogens.

Exposure Assessment. We then determined which exposure pathways were of potential concern for each problem area and focused on those likely to be most significant. For example, ingestion of contaminated fish was considered to be the pathway of most concern for discharges to surface waters. We used the monitoring or modeling data available to determine an average dose to an exposed individual. We also determined the population potentially exposed to the contaminants for each problem area.

Risk Characterization. Using the information from the toxicity and exposure assessments, we determined the residual risk posed by each problem area. For the carcinogens, we were generally able to calculate a range for individual cancer risk by multiplying the CAG potency factor by the dose. We then calculated an upper bound population risk (i.e., number of cancer cases that would be expected) on an annual basis by multiplying the individual risk by the exposed population and dividing by 70 years. This provided us with a relative estimate of expected number of cancer cases across problem areas.

Non-cancer Methodology

The non-cancer analysis was not as straightforward as the cancer analysis because a variety of different health effects were considered, including cardiovascular, developmental, hematopoietic, immunologic, kidney, liver, mutagenic, neurotoxic, reproductive, central nervous system, gastrointestinal, and respiratory effects. Both acute and chronic effects were considered, depending on the typical concentration of the pollutant being considered. The NCRP developed a methodology for non-cancer analysis that took into account the severity of the health effect and the probability that any adverse health effect would occur. We used the severity index derived in the NCRP, which ranked more than 100 different health endpoints, and then developed a severity scoring system of 1 to 4, with 1 reflecting mild health effects and 4 reflecting severe health effects. The scoring reflected the extent to which the health effect was life threatening and whether it was permanent, reversible, or manageable therapeutically. The NCRP also developed a measure of potency, which was termed the "individual exposure ratio." This ratio was the estimated exposure concentration divided by a Reference Dose (RfD--the RfD is the dose below which it is unlikely that adverse effects to humans will occur). The higher the concentration above the RfD, the higher the ratio. That is, we expect the probability of adverse effects occurring to increase as the concentration increases above the RfD. If no RfD was available, we chose another appropriate guideline. This individual exposure ratio was also then scaled from 1 to 4.

Also, we estimated the exposed population on a scale of 1 to 4. The population size used by the NCRP was reduced to reflect the smaller population of Region I.

As a result, for each problem area with non-cancer effects we were able to determine a score for population exposed, for severity of effect, and for potency. We combined these scores in various ways and discussed each problem area in detail to determine a relative ranking for non-cancer effects.

After the work group came to consensus on the separate rankings for cancer and non-cancer health effects, we combined the two lists into one ranking. This proved to be the most difficult step of the analysis because it involved implicit weighing of cancer versus non-cancer effects.

The reader is referred to the Public Health Risk Work Group Report and the NCRP Cancer and Non-cancer appendices for a more in-depth discussion of the overall approach and methodology.

Ecological Risk Work Group

There is no generally accepted methodology for the evaluation of ecological risks. Many ecological risk assessments are qualitative analyses, though methodology is currently being developed to allow for a more quantitative assessment of ecological risk. The Ecological Risk Work Group reviewed the methodology developed by the NCRP, and decided to do a semiquantitative analysis, generally following the NCRP approach.

The work group conducted the analysis in five major steps:

- *Step 1*: Identify problem areas for which ecological risk will be evaluated and determine stressors associated with each area
- *Step 2*: Identify ecosystems of concern in the Region
- *Step 3*: Evaluate ecological risks for each stressor and ecosystem combination
- *Step 4*: Aggregate risk estimates across stressors within each problem area/ecosystem combination
- *Step 5*: Aggregate risks for each problem area across ecosystems and rank problem areas

These steps are discussed in more detail below.

Step 1: Identify problem areas for which ecological risk will be evaluated and determine stressors associated with each area.

The Ecological Risk Work Group first reviewed the list of 24 environmental problems and deleted those that did not have significant ecological effects, or were contained in the ecosystem descriptions, or were evaluated as part of another problem area. The following problems were therefore eliminated from the analysis:

- Radon
- Indoor Air Pollutants Other than Radon
- Radiation from Sources Other than Radon
- Discharges to Estuaries, Coastal Waters, and Oceans from All Sources (evaluated as ecosystems)
- Drinking Water
- Asbestos
- Lakes, Ponds, and Impoundments (evaluated as ecosystem)
- Lead (ecological impacts evaluated as part of surface water discharge problem areas)

The work group leads for each problem area identified the major ecological stressors for each problem area. Group members used information developed by the Cornell Ecosystems Research Center for the NCRP to determine stressors. Examples of stressors are metals, toxic organics, oil, nutrients, and nutrient growth.

Step 2: Identify ecosystems of concern.

The work group began with a list of ecosystems from the Cornell study, modifying the list to make it more relevant to New England. The ecosystem list was as follows:

- Marine
- Estuaries
- Tidal wetlands
- Streams
- Lakes
- Wetlands (freshwater)
- Terrestrial
- Agricultural
- Ground water
- Air

The last two categories, ground water and air, are not ecosystems, but the group considered these because they are valuable environmental resources in Region I. As the analysis progressed, it became clear that when evaluating impacts to ground water and air we were actually doing a welfare analysis rather than strictly an ecological analysis. The value of this analysis will be discussed in a later section.

Step 3: Evaluate the ecological risks for each stressor and ecosystem combination.

Work group members worked directly with the contractor to collect regional data to determine impacts of stressors on each ecosystem for each problem area. The major sources contributing to adverse ecological impacts were identified for each problem.

Step 4: Aggregate risk estimates across stressors within each problem area/ecosystem combination.

The work group ranked the impact to each ecosystem from each problem area on a scale of 1 (low impact) to 5 (high impact). Work group members provided an estimate of the percentage of the problem covered, and the uncertainty, for each ecosystem impact.

Step 5: Aggregate risks for each problem area across ecosystems and rank problem areas.

After evaluating each problem area for its impacts on each ecosystem of concern, the work group members discussed the aggregation of these risks across ecosystems to rank problem areas. The group was not comfortable taking this step as we believed it involved making judgments about the value of various ecosystems. Still, the results of the ecosystem-specific rankings allowed the problems to be divided into groups of relatively high risks and medium risks. The problems initially eliminated from the analysis in Step 1 were considered to be of low ecological risk. The reader is referred to the Ecological Risk Work Group Report for a more complete discussion of this analysis.

Risk Management Work Group

This work group, unlike the Public Health and Ecological Risk Work Groups, had no Headquarters model to follow, because Headquarters did not consider risk management factors in the NCRP. Therefore, this group had to develop and apply its own methodology to evaluate risk management issues. The group first determined which risk management factors to evaluate. The factors chosen for evaluation were public perception, available resources, economic impact, effective technology, and legal authority. The work group then divided into teams of two to determine appropriate ranking criteria for each factor. Each team developed a scale of 1 to 5 that gave an indication of whether a problem was relatively difficult (1) or easy (5) to manage for that particular factor. Several groups also developed ways of adjusting or modifying the scores. Each scoring system was presented to the group for discussion and critique. Next, each group gathered information about each problem area in order to evaluate it for the specific management factor. Information was gathered in a variety of ways, such as sending questionnaires to staff people in each division who were knowledgeable about a problem area, interviewing program managers, or surveying community environmental groups. Each team developed a draft ranking paper for its risk management factor and presented the draft paper to the work group for discussion. Rankings were modified and finalized following the group discussion and agreement. Below are brief factor definitions and a summary of each factor's rating scale. The reader is referred to the Risk Management Work Group Report for a more complete discussion of this analysis.

Public Perception

The Public Perception Team evaluated how the public perceives the risks posed by each of the 24 environmental problem areas. Depending on the characteristics of an environmental problem, people may perceive it as more or less risky. For example, an involuntary, unfamiliar risk is generally perceived as more risky than a voluntary, familiar risk. The team developed a scale of 1 to 5, with 1 indicating little or no public interest or awareness and 5 indicating a high level of public concern. The Risk Management Work Group assumed that a high level of awareness would make a problem easier to manage in general, although in some cases high awareness may make the situation more difficult to manage.

Available Resources

The Available Resources Team assessed the amount of resources available to the Region to address each of the 24 problem areas relative to the total resources needed to address the problem area in Region I. The focus was on work-years needed to carry out EPA programs and/or functions. The team developed a scale of 1 to 5, with 1 indicating a very low level of resource allocation and 5 indicating that there were adequate work-years to address the problem.

Economic Impact

The Economic Impact Team evaluated the cost of controlling each problem area by determining the cost per unit to control a particular problem, and then estimating the number of units in Region I to arrive at an estimated annual cost of control. The team developed a scale of 1 to 5, with 5 indicating a cost of less than $1 million dollars and 1 indicating a cost of $1 billion dollars or greater. A high score indicated a relatively low cost, making that problem relatively easier to control.

Effective Technology

The Effective Technology Team identified and evaluated the existence of methods to control the pollutants that cause the risk in each of the 24 problem areas. The methods identified included pollution control equipment and technologies and/or imposition of operation and maintenance (O&M) or management practices. The team developed a scale of 1 to 5, with 1 indicating that only experimental technology or no technology was available, and 4 indicating that off-the-shelf technology was available. The initial ranking of 4 could be adjusted up to a 5 if the size of the problem was large enough that the technology would have great potential for risk reduction.

Legal Authority

The Legal Authority Team evaluated the existence of statutory and regulatory authority for each problem area and also attempted to account for the adequacy of existing legislation. The team developed a scale of 1 to 5, with 1 indicating that there are no applicable laws, and 5 indicating that there is applicable federal and/or state law and case law supporting EPA or the state.

III. General Lessons Learned and Work Group Results

General Lessons

This section of the *Overview Report* makes some broad observations on the process and results, followed by a summary of the results of each work group analysis. Below are key observations:

- **The process of this project is as valuable as the results.** Although not an explicit goal at the outset of this project, involvement in the work group process was of great value to group members and to chairs. Many work group members were unfamiliar with environmental problems outside their area of expertise when they joined the group, but by the end of the process had considerably broadened their knowledge of these other areas. Also, work group members received hands-on training in risk assessment, an area unfamiliar to many when they joined the groups. This education was of personal and professional value to work group members, as well as to the agency as a whole. As EPA continues to move toward a cross-media approach to evaluating and controlling environmental problems, it is essential that EPA staff understand the "big picture." Many work group members commented about new perspectives gained as a result of interaction with people from many different programs. It may be difficult to measure the value of the process but it should not be underestimated.

- **The Risk Reduction Project is a first step toward developing a more analytical approach to planning and priority setting in Region I.** Historically, many planning decisions have been based on the professional judgment of senior agency managers. Over the past several years, we have been working to improve our planning process, with projects such as the Investment/ Disinvestment Project (for Fiscal Year 1988, Division Directors in Region I worked with states to propose regional initiatives as well as to specify disinvestments). The RRP was the first time that a methodology for assessing the risks posed by environmental problems was developed as a planning tool in Region I. We took the methodology developed by EPA Headquarters for the NCRP and modified it for regional use. We now have an analytical tool requiring data collection and analysis as well as the use of best professional judgment, and the tool can be used in an ongoing way to help us compare environmental problems. We also can use this process to help us go one step further, that is, to conduct a more narrow comparative risk evaluation of particular environmental problems and determine which sources or sites pose the greatest risks. With this information, we will be better equipped to shift resources within and between environmental programs.

- **The inconsistency of problem definitions complicated the analysis.** We agreed to use a list similar to the NCRP list for reasons discussed in Chapter II. Yet it was difficult to compare sources (such as Superfund sites) with receptors (such as Estuaries), with individual pollutants (such as Lead or Asbestos), or with

programs (such as Drinking Water). We frequently needed to revisit the definitions we had developed for each problem area to determine what to include. In addition, the definition of a problem area had a great impact on its ultimate ranking. For example, we did not include two significant contributors to drinking-water contamination, lead and radon, in the drinking-water analysis because they were part of pollutant-specific analyses. We attempted to avoid double-counting of health or ecological risks, by ensuring that a pollutant, source, or pathway that was included in a problem area definition was clearly excluded from other problem areas. We recommend that the Agency think very carefully about developing a more consistent means of dividing up the environmental pie when undertaking similar analyses in the future.

- **Regional data are often inaccessible.** Large amounts of data are located in government offices throughout the region, but this information is often poorly organized, not computerized, and therefore difficult to utilize. EPA and state agencies should put more effort into developing and improving data management systems.

- **Ranking is easiest when there are good supporting data, more difficult when we had to rely on best professional judgment, and most difficult when values and personal judgment entered into the ranking.** For example, the Public Health Risk Work Group had little difficulty ranking Radon, which was clearly a high-ranking problem, based on relatively good data. The work group had most difficulty determining a combined cancer/non-cancer list because it involved making implicit or explicit value judgments about the harm of cancer versus other health effects. Similarly, the Ecological Risk Work Group had little difficulty in ranking Industrial Discharges to lakes as being of low ecological risk, based on good regional data. Ecological Work Group members were able to identify which problem areas had high impacts on each ecosystem, but they were unable to prioritize these further because each of the ecosystems evaluated are considered to be of great value in Region I. The discussions involving judgment and values were often the most difficult part of the process, but ultimately the most valuable, because we learned from each other while working toward group consensus.

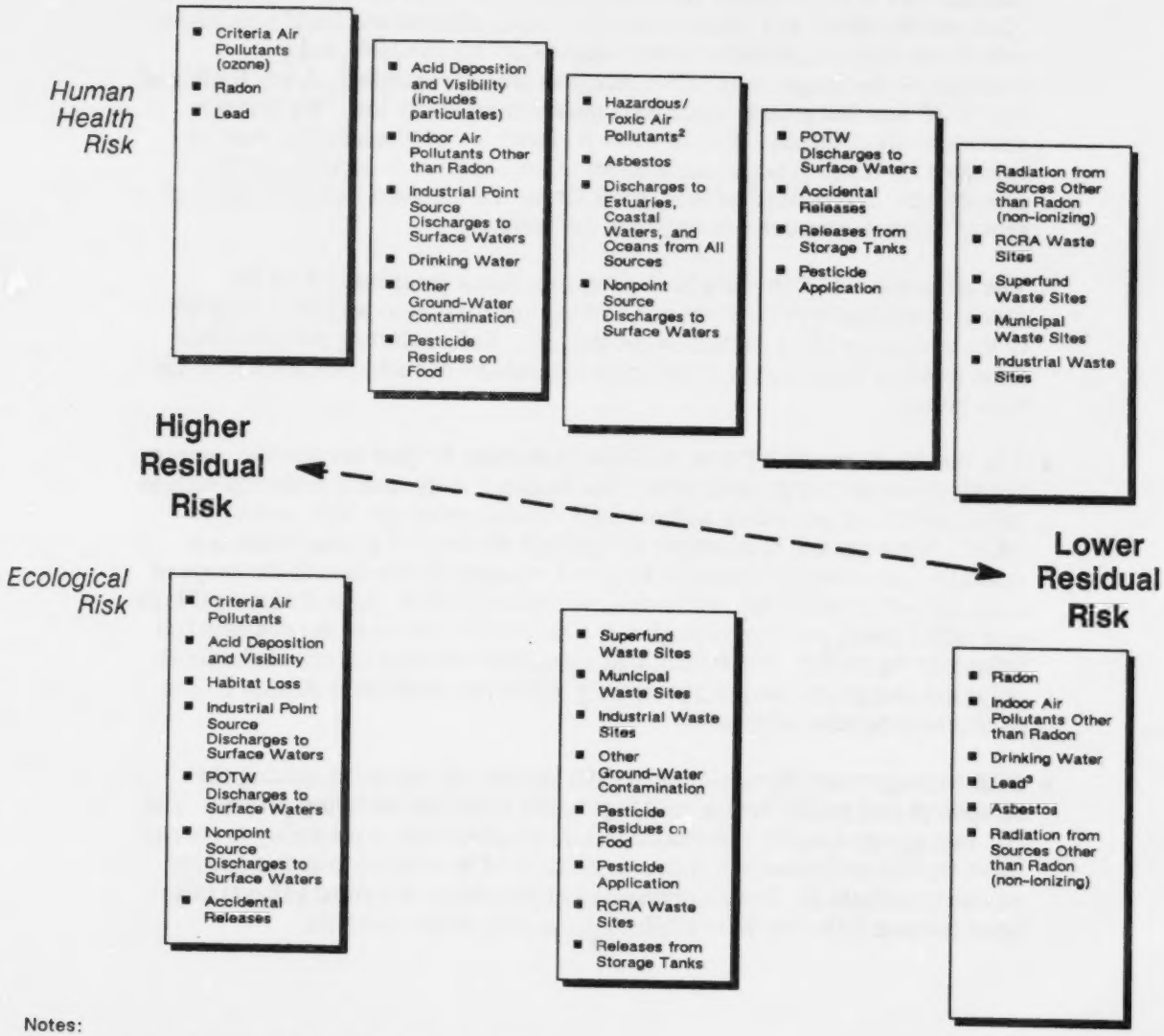
- **High ranking public health problems in general differ from high ranking ecological problems.** Ozone is the exception to this because it poses high residual risks to environmental receptors and to humans. The problem areas involving discharges to surface waters (industrial discharges to streams, POTW discharges to estuaries and streams, nonpoint source discharges to lakes) were all considered to pose high residual ecological risks but ranked from medium-high to medium-low as residual public health risks. Other high public health risks (radon, lead) were not high ecological risks and vice versa (see Table 2).

Table 2

Region I Comparative Risk Project

Summary of Results

(unranked within boxes[1])



Notes:

[1] Boxes represent categories of environmental problems that were judged to pose relatively similar risks.

[2] Hazardous/Toxic Air Pollutants were not ranked for ecological risk because of insufficient data.

[3] Ecological risks of lead were evaluated as part of Surface Water Discharge problem areas.

- **Rankings based solely on residual risk given present exposure patterns may underestimate the importance of ground water as an environmental resource.** Problems primarily affecting ground water ranked medium in the ecological risk evaluation and low in the public health risk evaluation, primarily because the exposures measured to date are, in most cases, relatively low. However, it is evident that a number of the environmental problem areas we evaluated--such as RCRA sites, Superfund sites, and municipal landfills--are contaminating ground-water aquifers that may be future drinking-water supplies and that may discharge contaminants into sensitive ecosystems. So, although the residual risks to public health and ecological receptors are not high relative to the other problem areas, this resource is clearly being affected and could pose higher risks in the future if alternative water supplies are not available and if contaminant discharges to sensitive receptors are not controlled. A key finding of the NCRP was that ground-water risks ranked consistently low. We find this conclusion shortsighted. Ground water is clearly a vital resource that must be protected for future generations, whether or not exposure is occurring at the present time. The Ecological Risk Work Group did a limited welfare analysis of ground water as a resource to highlight this concern.

- **The effectiveness of ongoing base programs has a great impact on the relative ranking results.** Problems ranking low may do so because a large part of the problem is being controlled successfully. Before shifting resources from these problem areas, we must determine the impacts of such shifts relative to the risks posed.

- **The results of the NCRP and the Risk Reduction Project are similar, except for the treatment of ground water.** The Region I study ranked problems such as radon, criteria air pollutants, and pesticide residues relatively high, as did the NCRP. We believe it is important to highlight the issue of ground water as a critical environmental resource in Region I, although it falls outside the scope of a narrow public health risk and ecological risk evaluation. Also, lead ranked high as a public health problem in Region I. This problem area was not evaluated on its own in the NCRP. We defined it as a problem area because our professional judgment recognized lead as a potentially significant problem in Region I. The results bore out that judgment.

- **Risk Management Work Group results are the key elements linking the ecological and public health rankings to the Regional planning process.** The risk management results summarize factors which influence the ability to control these various environmental problems and should be referred to as this project proceeds to Phase II. The economic impact analysis is of limited value at this point because little data were available for a comparative analysis.

- **Institutional barriers made it difficult to conduct this analysis in an objective fashion, and may affect the use of its results.** The structure of EPA reflects most of our major environmental statutes, which are generally media or problem specific, i.e., air, water, waste, pesticides. This compartmentalization of environmental problems has created a difficult climate for analyzing or resolving complex multimedia issues at EPA, and has also resulted in a work force that is encouraged to be narrowly focused and may be resistant to change.

- **The comparative risk evaluation project was a massive undertaking, requiring the significant time and energy of approximately 35 individuals in Region I over a nine month period.** In order for an effort like this to succeed, it is crucial that there be management support for the project at all levels. Staff persons assigned to a project of this magnitude should be relieved of some of their other duties so that they can devote sufficient attention to the analysis. Region I should think carefully about the resources needed to conduct this type of analysis and weigh the value of it prior to committing to the project.

- **Interpretation and utilization of results must be done with caution.** As discussed above, there are two key points to bear in mind. First, evaluation of residual risks **only** may miss important aspects of environmental problems such as use and source trends and the beneficial impact of ongoing base programs. For example, the waste problem areas, such as Superfund sites, may rank low because large resources are allocated to controlling the problem and because ground-water exposures at the present time are relatively low. Second, problem areas as defined in this report may be difficult to compare to standard EPA programs (e.g., the exclusion of radon and lead from the drinking-water problem area).

Public Health Risk Work Group

The results of the analysis performed by the Public Health Risk Work Group are presented in Table 3. This table combines the results of the cancer and non-cancer analyses, done separately by the work group, to arrive at a list of environmental problems posing residual public health risks of concern in Region I. The environmental problem areas are ranked in five categories, with category 5 posing the highest residual public health risk and category 1 posing the least residual risk. Within each category the problem areas are listed in the order they were originally developed for the project. No relative ranking within categories was performed and none should be inferred. The cancer and non-cancer rankings are presented separately in the Public Health Risk Work Group Report. The work group had a very difficult time determining the combined list, because of the implicit value judgments which were made in merging the cancer/non-cancer lists. The group considered both cancer and non-cancer effects when placing a problem area in the combined list. We used the results of data collection and analysis as much as possible in developing the ranking, along with our best judgment as environmental professionals. The list, which provides a relative ranking of

Table 3

Relative Residual Public Health Risk Ranking
(unranked within categories)

Problem Area	Substances/Exposures Investigated	Comments
Category 5		
Criteria Air Pollutants	Ozone Carbon Monoxide Particulate Matter	Cancer: Category 1--Assumed no cancer risk since all criteria air pollutants are currently considered non-carcinogenic Non-cancer: Category 5--Driven by large-scale exposure to high ozone levels across the region
Radon	Radon	Cancer: Category 5--Up to 1,500 excess cancers predicted annually from exposure in homes Non-cancer: Category 2/1--Assumed low. Some non-cancer effects likely
Lead	Lead	Cancer: Category 1--Assumed no cancer risk since chemical is not currently considered carcinogenic Non-cancer: Category 5--Driven by ingestion of soil or inhalation of lead-contaminated dust by children, resulting in lead poisoning and learning disabilities
Category 4		
Acid Deposition and Visibility	Acid Aerosols--Sulfates and Nitrates	Cancer: Category 1--Assumed no cancer risk since substances are not currently considered carcinogenic Non-cancer: Category 4--Influenced by widespread respiratory symptoms and hospital admissions due to inhalation of elevated acid aerosol levels
Indoor Air Pollutants Other than Radon	Carbon Monoxide Nitrogen Oxides Particulate Matter Formaldehyde Benzene Carbon Tetrachloride Phthalate Esters Chlordane Heptachlor Tobacco Smoke Trichloroethylene Tetrachloroethylene	Cancer: Category 3--Estimated 1 to 50 excess annual cancers from inhalation of a mixture of pollutants; high individual risk Non-cancer: Category 3--Driven by carbon monoxide exposures, aggravating angina for chronic effects and causing acute cardiac impairment
Industrial Point Source Discharges to Surface Waters	PCBs, Dioxin, Mercury	Cancer: Category 3--Estimated 15 to 30 excess annual cancers from ingestion of fish contaminated with PCBs Non-cancer: Category 4--Influenced by ingestion of mercury contaminated fish at up to 25 times the RfD
Drinking Water	Total Trihalomethanes (TTHM), Arsenic, Radionuclides, Nitrates, Bacteria, Pathogens	Cancer: Category 3--Estimated 20 excess annual cancers from ingestion of TTHM and arsenic Non-cancer: Category 4--Driven by outbreaks of Giardia-related gastrointestinal disease

(continued)

Table 3 (Continued)

Relative Residual Public Health Risk Ranking
(unranked within categories)

Problem Area	Substances/Exposures Investigated	Comments
Category 4 (continued)		
Other Ground-Water Contamination	Pathogenic Microorganisms, Sodium, Nitrates, Pesticides, Solvents, and Petroleum Products	Cancer: Category 2--Estimated 1 excess annual cancer from ingestion of dichloromethane from septic tanks/cesspools Non-cancer: Category 4--Driven by outbreaks of hepatitis and gastrointestinal disease caused by septic tank contamination of drinking water wells
Pesticide Residues on Food	1 Herbicide 2 Fungicides 1 Insecticide 1 Growth Regulator	Cancer: Category 4--Estimated up to 320 excess annual cancers by scaling NCRP data down to region, a method that may overestimate the regional impact Non-cancer: Category 2/1--Assumed low non-cancer risk because of lack of evidence that exposures exceed allowable levels
Category 3		
Hazardous/Toxic Air Pollutants	TCE Carbon Tetrachloride	Cancer: Category 3--Estimated 10 excess annual cancers based on monitored background concentrations of urban toxic soup; may underestimate effect because of low percent of problem covered Non-cancer: Category 2/1--Quantitative risk not estimated because of lack of inhalation reference doses to evaluate systemic effects from these pollutants
Asbestos	Asbestos	Cancer: Category 3--Estimated 185 excess annual cancers; work group felt estimate was conservative Non-cancer: Category 2/1--Assumed low non-cancer risk
Discharges to Estuaries, Coastal Waters, and Oceans from All Sources	Heptachlor PCBs DDT HCB	Cancer: Category 3--Estimated 90 excess annual cancers from ingestion of contaminated fish Non-cancer: Category 2/1--Estimated low risk since exposures do not exceed RfDs
Nonpoint Source Discharges to Surface Waters	PCBs Dioxin Mercury	Cancer: Category 3--Estimated less than 30 excess annual cancers from ingestion of fish contaminated by PCBs; not judged as significant a contributor as industrial point sources Non-cancer: Category 2/1--Qualitatively estimated as smaller contributor to surface waters than industrial point sources

(continued)

Table 3 (Continued)

Relative Residual Public Health Risk Ranking
(unranked within categories)

Problem Area	Substances/Exposures Investigated	Comments
Category 2		
POTW Discharges to Surface Waters	PCBs Dioxin Mercury	Cancer: Category 2–Estimated less than 10 excess annual cancers from ingestion of fish contaminated with PCBs; judged a smaller contributor than nonpoint or industrial point sources Non-cancer: Category 2/1–Qualitatively estimated as a smaller contributor to surface waters than nonpoint or industrial point sources
Accidental Releases	Chlorine Mineral Acids Ammonia Organic Solvents Organic Toxics	Cancer: Category 1–Assumed low cancer risk Non-cancer: Category 3–Influenced by respiratory problems as severe as respiratory pneumonia; estimates based on reported accident data
Releases from Storage Tanks	Gasoline Home Heating Oil Diesel Fuel	Cancer: Category 2–Qualitative ranking based on best judgment of risk relative to problem areas with more data; judged similar to hazardous waste risks Non-cancer: Category 3–Qualitative ranking based on best judgment of risks relative to other problem areas; high number of tanks drives higher rating
Pesticide Application	Herbicides Fungicides Insecticides	Cancer: Category 2–Estimated less than 1 excess annual cancer derived from scaling down national figures Non-cancer: Category 3–Qualitative ranking based on best judgment of risks relative to other problem areas
Category 1		
Radiation from Sources Other than Radon (non-ionizing)	Extremely Low Frequency (ELF) Radiation	Cancer: Category 2–Qualitative ranking based on best judgment of risks relative to other problem areas; high degree of uncertainty in available data Non-cancer: Category 2/1–Qualitative ranking based on best judgment of risks relative to other problem areas

(continued)

Table 3 (Continued)

Relative Residual Public Health Risk Ranking
(unranked within categories)

Problem Area	Substances/Exposures Investigated	Comments
Category 1 (continued)		
RCRA Waste Sites	18 Typical Compounds in Waste Stream	Cancer: Category 2--Estimated 1 to 10 excess annual cancers influenced most heavily by modeled hazardous waste incineration impacts; high degree of uncertainty Non-cancer: Category 2/1--Estimated low risk since exposures do not exceed RfDs
Superfund Waste Sites	PCBs, Arsenic, Tetrachloroethylene, Benzene, Vinyl Chloride	Cancer: Category 2--Estimated about one excess annual cancer Non-cancer: Category 2/1--Estimated low risk since exposures generally do not exceed RfDs
Municipal Waste Sites	Vinyl Chloride Arsenic Tetrachloroethylene Dichloromethane Carbon Tetrachloride	Cancer: Category 2--Qualitatively estimated a few excess annual cancers due to contamination of ground-water wells; limited available data Non-cancer: Category 2/1--Estimated low risk since exposures do not exceed RfDs
Industrial Waste Sites	Vinyl Chloride Arsenic Tetrachloroethylene Dichloromethane Carbon Tetrachloride	Cancer: Category 2--Qualitatively estimated a few excess annual cancers due to contamination of wells; limited available data Non-cancer: Category 2/1--Estimated low risk since exposures do not exceed RfDs

residual public health risks, was the consensus of the work group. We believe that a different group evaluating the same data might move some problem areas up or down one category, especially in the middle of the range, but it is unlikely that they would move them up or down two categories. Some of the major conclusions of the Public Health Risk Work Group are as follows:

- Indoor radon exposure, which is associated with lung cancer, poses a significant potential health threat in Region I. The cancer cases associated with this problem area may be up to an order of magnitude greater than other problem areas that pose a cancer risk.

- Lead exposure from all sources poses a significant public health threat in New England, particularly to young children who may be learning-disabled as a result of mild to severe lead poisoning.

- Exposure to ozone above the National Ambient Air Quality Standards occurs frequently in Region I and is associated with respiratory ailments that may affect large populations in New England.

- Separating the residual public health risks posed by the three types of discharges to surface water is difficult. After much group discussion and input from the Water Division staff, we agreed to rank these problems as follows:

  -- Industrial Point Source Discharges to Surface Waters--category 4

  -- Nonpoint Source Discharges to Surface Waters--category 3

  -- POTW Discharges to Surface Waters--category 2

  We ranked the problem areas in the above order because we evaluated fish consumption as the pathway of greatest concern, considering chemicals such as PCBs and metals that are most likely to be associated with industrial discharges.

- Pesticide Residues on Food is a significant public health concern in Region I. We did not have regional data that justified placing it in the highest category but, based on a scaling down of national data, pesticide residues on food consumed in New England was placed in category 4.

- The waste problem areas, including Superfund Waste Sites, RCRA Waste Sites, Municipal Waste Sites, and Industrial Waste Sites, pose low residual public health risks. These are primarily ground-water contamination problems and may or may not be affecting drinking-water supplies at the present time. These sources are contaminating aquifers that may be valuable future sources of drinking water, but present exposures are generally low. The contamination of ground water as a resource is of great concern in Region I and was evaluated in more detail by the Ecological Risk Work Group. When focusing only on residual

public health risks, the public health impact of this ground-water contamination is relatively low. Other pathways of exposure from these problem areas include direct contact with contaminated soils and water and inhalation of contaminated air. Although from our analysis it appears that municipal landfills pose risks similar to those from Superfund sites, the work group agreed that there is great uncertainty in this area, which suggests that a more in-depth analysis would be useful.

Ecological Risk Work Group

The Ecological Risk Work Group evaluated 15 environmental problems thought to pose adverse ecological effects. We considered the impact of each problem area on each of eight ecosystems and two environmental resources (ground water and air). From this process, the work group identified the ecosystems that were under the greatest stress from each problem area. We separated the problem areas into groupings of high, medium, and low residual ecological risk based on the level of stress to the ecosystems. We also evaluated the cumulative impact of various problem areas on each ecosystem. The results of the Ecological Risk Work Group analysis are presented in Table 4. Some of the major conclusions are as follows:

High Residual Ecological Risk

Seven problem areas clearly pose significant ecological risks in Region I:

- Ozone, a Criteria Air Pollutant, has adverse impacts on forests and may affect crop yields.
- Acid deposition has adverse impacts on lakes in New England and also contributes to forest decline.
- All discharges to surface waters have adverse impacts on aquatic life in streams, lakes, ponds, impoundments, and estuaries. This includes three problem areas: Industrial Point Source Discharges, POTW Discharges (including combined sewer overflows and storm-water discharges), and Nonpoint Source Discharges.
- Habitat loss--significant loss of uplands and wetlands, which are important areas for spawning and breeding--is occurring in New England.
- Accidental Releases are a significant concern. Although catastrophic accidental releases are not common, this problem area was highlighted as significant because major oil spills in the estuarine, tidal wetlands, and/or marine ecosystems would be likely to have drastic environmental impacts.

Table 4

Ecological Problem Area Ranking
(unranked within categories)

Environmental Problem	Sources and Stresses	Ecosystems Most Significantly Affected
Category 5		
1. Criteria Air Pollutants	Ozone is the most significant stressor	Terrestrial--Ozone is considered to cause the decline of forests, especially at higher elevations. Agriculture--Several crops have shown decreases in yield due to ozone.
2. Acid Deposition and Visibility	Lowering of pH and buffering capacity	Lakes--New England lakes are experiencing significant acidification due to acid deposition, which affects aquatic distribution. Terrestrial--Acid deposition contributes to decline of forests, particularly at higher elevations.
7. Industrial Point Source Discharges to Surface Waters	Discharge of toxics, especially in water with low dilution ratios	Streams--Toxic plants affect sediments and aquatic life.
8. POTW Discharges to Surface Waters (includes Combined Sewer Overflows (CSOs) and stormwater dicharges)	Discharge from CSOs and stormwater of nutrients and toxics; POTW discharge of chlorine, nutrients, and industrial waste to water quality limited streams	Estuaries--Toxics and nutrients affect plants, sediments, and aquatic life. Streams--These discharges are toxic to aquatic organisms. Lakes, Ponds, Impoundments--Nutrients and toxics build up in impoundment sediments.
9. Nonpoint Source Discharges to Surface Waters	Runoff of nutrients and toxic chemicals into lakes and streams	Lakes--Nonpoint source runoff causes eutrophication. Streams--Runoff of toxics, including pesticides, has significant impact on aquatic life.
11. Habitat Loss	Conversion of undeveloped land to residential and commercial property	Terrestrial--Significant loss of land to development affects the habitat environment and breeding areas. Wetlands (freshwater)--Significant loss of land as a habitat breeding and spawning area occurs. Agriculture--Significant loss of habitat environment and breeding area occurs.
17. Accidental Releases	Oil spills from shipping and drilling	Estuaries and tidal wetlands--Major oil spill could destroy habitat and spawning area and other uses. Marine--The drilling at Georges Bank could destroy habitat spawning.
Category 4		
14. Superfund Waste Sites	Discharges of toxics from leachate	Wetlands (freshwater)--Approximately 50% of the sites are adjacent to streams or freshwater wetlands. Toxics affect plants, sediments, and aquatic life.
15, 16. Municipal and Industrial Waste Sites	Discharges of toxics from leachate	Wetlands (freshwater)--similar to 9.
19. Other Ground-Water Contamination	Septic tank discharges of nutrients	Lakes--Nutrients contribute to eutrophication of New England lakes.
20, 21. Pesticide Residues on Food/Pesticide Application	Residual runoff from application	Lakes--Pesticide use has significant impacts on aquatic life, particularly when directly applied. Wetlands--Use in mosquito control can affect aquatic life and vegetation. Terrestrial--Spraying can affect habitat.
Category 3		
13. RCRA Waste Sites	Discharge of toxics from leachate	Streams and wetlands (freshwater): Toxics affects plants and sediments.
18. Releases from Storage Tanks	Discharges of toxics from leachate	Streams and wetlands (freshwater): Toxics affect plants and sediments.
Unknown		
3. Hazardous/Toxic Air Pollutants		Unknown.

Note: Toxics includes organic chemicals, metals, and pesticides.

Problem areas considered to pose low ecological risk (Category 2/1) were not evaluated by the work group, and were not included in this table.

Medium Residual Ecological Risks

The environmental problem areas which primarily affect the ground-water resource appear to pose medium to medium-high residual ecological risks. These problems include Superfund Waste Sites, RCRA Waste Sites, Municipal Waste Sites, Industrial Waste Sites, Releases from Storage Tanks, Other Ground-Water Contamination, and impacts from Pesticide Application.

Generally, contaminants from sources related to these problem areas are in highest concentrations in ground water, and may be discharging or running off into surface waters and wetlands, threatening these ecosystems. An ecological risk evaluation, which looks strictly at ecological receptors, will find that these problems have relatively less ecological impact than sources directly discharging to water and air. The Ecological Risk Work Group included ground water as an "ecosystem" category precisely so that the serious problem of ground-water contamination would not get lost in the overall analysis. In many ways, the contamination of ground water poses primarily a welfare risk because it affects present and future drinking water supplies. The work group agreed that ground-water quality in New England is seriously threatened by the problem areas listed above.

Low Ecological Risks

All of the problem areas not evaluated were considered to pose low ecological risks. These problems include Radon, Indoor Air Pollutants Other than Radon, Drinking Water, Lead (ecological impacts evaluated under discharges to surface waters), Asbestos, and Radiation from Sources Other than Radon.

Unknown

Impacts from Hazardous/Toxic Air Pollutants were ranked as unknown because very little data are available to evaluate this problem, although there is concern regarding potential environmental impacts. It may be valuable to look more closely at this problem area in Phase II.

Risk Management Work Group

The Risk Management Work Group evaluated different factors that affect how easy (5) or difficult (1) it is to control an environmental problem. The factors evaluated were public perception, available resources, economic impact, effective technology, and legal authority. Table 5 presents results of the Risk Management Work Group analysis. Some general conclusions that can be drawn from this analysis are as follows:

- Overall observation--No problem area is uniformly "easy" to manage. Each of the problem areas scored relatively high for certain factors and relatively low for others. However, a certain group of problems do appear to be more difficult to control overall, including Acid Deposition, Radon, Indoor Air Pollution, Wetlands/Habitat Loss, Industrial Waste Sites, Municipal Waste Sites, Other Ground-Water Contamination, and Lead.

Table 5

Risk Management Work Group
Summary Ranking

	Problem Area	Public Perception	Available Resources	Economic Impact	Legal Authority	Effective Technology
1.	Criteria Air Pollutants	3	4	1	5	4
2.	Acid Deposition and Visibility	3	2	3	1	5
3.	Hazardous/Toxic Air Pollutants	4	3	1	3	5
4.	Radon	3	3	3	1	4
5.	Indoor Air Pollutants Other than Radon	3	3	--	1	4
6.	Radiation from Sources Other than Radon	1	5	5	1	4
7.	Industrial Point Source Discharges to Surface Waters	4	3	3	5	5
8.	POTW Discharges to Surface Waters	3	4	2	5	5
9.	Nonpoint Source Discharges to Surface Waters	2	3	2	3	4
10.	Discharges to Estuaries, Coastal Waters, and Oceans from All Sources	3	4	2	4	5
11.	Wetlands/Habitat Loss	2	2	--	2	3
12.	Drinking Water	5	2	3	3	4
13.	RCRA Waste Sites	4	2	3	4	4
14.	Superfund Waste Sites	5	4	2	3	3
15.	Municipal Waste Sites	3	1	2	2	4
16.	Industrial Waste Sites	3	1	3	2	4
17.	Accidental Releases	4	3	4	5	3
18.	Releases from Storage Tanks	3	4	2	3	4
19.	Other Ground-Water Contamination	3	2	--	3	3
20.	Pesticide Residues on Food	2	3	4	4	4
21.	Pesticide Application	2	3	4	4	4
22.	Lead	3	3	1	3	4
23.	Asbestos	4	3	2	5	5
24.	Lakes, Ponds, and Impoundments	2	3	--	3	5

-- = No cost data available.

Note: 1 = Most difficult to control; 5 = easiest to control.

- Public Perception--A problem that ranked high on the public perception scale indicated that this area was of great concern to the public in Region I. Unlike the other risk management factors, which are easier to manage as they rank higher, a problem that ranks "high" in public perception may be either easier or more difficult to manage. It may be easier to manage a problem if the public is informed, concerned, and cooperative in finding a solution. It may also be more difficult to control an environmental problem if the public is concerned but views the government as unresponsive and untrustworthy. Superfund Waste Sites and Drinking Water are the two problem areas which ranked highest in public perception of risk.

- Resources--Almost all programs are underfunded, with committed resources averaging about 50 percent of total need. Problems with little regulatory authority have minimal resources. The differences in workload models among programs may be having a great influence on these results, because the completeness and accuracy of the models varies widely.

- Economic Impact--This proved to be the most difficult factor to evaluate because there were little comparable cost data available to evaluate problem areas against each other. More data gathering and analysis are necessary to make this information useful and comparable.

- Effective Technology--The work group found that there were no problem areas without any effective control technologies, and that most of the available technology was proven rather than experimental.

- Legal Authorities--As expected, the older, more established programs have more adequate legal authority as well as case law supporting them. Newer programs such as Superfund appear to have adequate authority, but the law has not been implemented for a long enough period to determine its effectiveness. Some of the problem areas--such as Acid Deposition, Radon, Indoor Air Pollution, and Radiation Other than Radon--have little or no legal authority.

The reader is referred to the three Work Group Reports for more detailed discussions of the results.

IV. Summary of Ranking Information for Each Environmental Problem Area

The summary evaluations for each environmental problem area include the problem area definition, the risks evaluated and the rankings assigned by the Public Health Risk Work Group (Residual Public Health Risk) and the Ecological Risk Work Group (Residual Ecological Risk), and the factors ranked by the Risk Management Work Group (Risk Management Factors). For the latter, refer to the Risk Management Key on page IV-26. For detailed information on the problem areas and estimates of the portion of the problem examined and the uncertainty of the risk estimates, refer to the appendices in the Public Health Risk and the Ecological Risk reports, and the chapters on evaluation factors in the Risk Management report.

1. Criteria Air Pollutants

Problem Area Definition

This problem area includes exposure to criteria air pollutants, particularly through exceedances of the National Ambient Air Quality Standards (NAAQS) promulgated under the Clean Air Act to protect human health and welfare. The criteria air pollutants currently regulated are sulfur dioxide, particulates, carbon monoxide, nitrogen oxides, ozone, and lead. Lead is not included in this problem area because it is evaluated separately as problem area #22. Major sources of these pollutants are motor vehicles, industrial and commercial facilities, and residential fuel burning.

Residual Public Health Risk

- Evaluated ozone and carbon monoxide--These pollutants currently exceed NAAQS in Region I. Pollutants below NAAQS were not evaluated. Particulate matter was considered as part of Acid Deposition and Visibility (problem area #2).
- Evaluated increased risk of asthma attacks, restricted activity, aggravated angina, and death.
- Ranked in highest category (5) for overall residual public health risk.
  - -- Ranked in category 1 for cancer risk because pollutants are not carcinogens
  - -- Ranked in category 5 for non-cancer risk because large populations are exposed to relatively high levels of ozone

Residual Ecological Risk

- Focused on effects of ozone NAAQS exceedances. The most significant impacts were on terrestrial and agricultural ecosystems (i.e., forest growth damage and reduced crop yields).
- Ranked in highest category for ecological risk because of impacts on terrestrial and agricultural ecosystems. Adverse effects on wetlands are probable.

Risk Management Factors

- Public Perception--Ranked 3 because the public has moderate concern about these pollutants.
- Available Resources--Ranked 4 because Region I is funded at approximately 60 percent to 65 percent of the workload model resource level.
- Economic Impact--Ranked 1 because control costs are estimated at $1.4 billion per year.
- Effective Technology--Ranked 4 because off-the-shelf technology is available.
- Legal Authority--Ranked 5 because laws are considered adequate and are enforced.

2. Acid Deposition and Visibility

Problem Area Definition

This problem area includes both wet and dry acid deposition. Some gases emitted into the atmosphere react with sunlight, water vapor, and oxygen to form acid compounds. When these compounds are suspended in the atmosphere, they are referred to as acidic aerosols. Wet deposition occurs when the acidic compounds fall as acid rain or snow. These acidic compounds may also combine with dust or other dry particles and fall as dry deposition. The pollutants that contribute to acid deposition are already regulated under the Clean Air Act; however, deposition can occur even when emissions of these compounds meet EPA standards. Visibility was also included in the definition, although it was not explicitly addressed by all work groups.

Residual Public Health Risk

- Evaluated inhalation exposures that may lead to respiratory ailments, increased hospital admissions, and death for children and adults. Particulate matter was also considered in this problem area. Acid aerosols are a portion of the particulate matter exposure.
- Ranked in medium-high category (4) for overall public health risk.
  - -- Ranked in category 1 for cancer risk because pollutants are not carcinogens
  - -- Ranked in category 4 for non-cancer risk

Residual Ecological Risk

- Effects on aquatic and terrestrial ecosystems included decrease in pH of surface waters, destruction of flora and forest canopy, disruption of life-cycle processes, leaching of toxic metals from soils, and destruction of the acid neutralizing capacity of soils.
- Ranked in the highest category for ecological risk because of the impacts of acid deposition on lakes. Terrestrial ecosystems are also impacted significantly.

Risk Management Factors

- Public Perception--Ranked 3 because the public has moderate concern about the problem.
- Available Resources--Ranked 2 because regional funding (60 percent of the workload model) is considered inadequate by the Regional Program Manager and the work group.
- Economic Impact--Ranked 3 because costs of clean coal technology are estimated at $60 million per year.
- Effective Technology--Ranked 5 because off-the-shelf technology could greatly reduce the problem.
- Legal Authority--Ranked 1 because there are no laws to control acid deposition. (Acid deposition occurs even when pollutants meet Clean Air Act standards).

3. Hazardous/Toxic Air Pollutants

Problem Area Definition

This problem area includes exposure to airborne toxic and hazardous air pollutants from routine or continuous emissions by outdoor point and nonpoint sources. Typical pollutants include formaldehyde, benzene, chromium, gasoline vapors, incomplete combustion products, airborne pathogens, and a variety of other toxic compounds. Major sources include large industrial facilities; clusters of small commercial facilities; waste treatment, storage, and disposal facilities; motor vehicles; commercial solvent users; and cooling towers.

Residual Public Health Risk

- Evaluated monitoring data for chromium, arsenic, benzene, perchloroethylene, trichloroethylene, and carbon tetrachloride and extrapolated concentrations for an additional 22 pollutants.
- Ranked in the medium category (3) for overall residual public health risk.
  - -- Ranked in category 3 for cancer risk
  - -- Non-cancer effects not evaluated

Residual Ecological Risk

- Risks were characterized as unknown because of the lack of data on ecological effects of hazardous air pollutants.

Risk Management Factors

- Public Perception--Ranked 4 because the public has relatively high concern about this problem.
- Available Resources--Ranked 3 because regional funding (between 33 percent and 70 percent of the workload model) is considered inadequate by the Regional Program Manager, particularly in air toxics support for Superfund.
- Economic Impact--Ranked 1 because control costs are estimated at $1.5 billion per year.
- Effective Technology--Ranked 5 because off-the-shelf technology could greatly reduce the problem.
- Legal Authority--Ranked 3 because laws exist, although they have not been fully implemented.

4. Radon

Problem Area Definition

Radon is a radioactive gas produced by the decay of radium, which occurs naturally in soil and rock. This problem area evaluates exposure to radon, which can occur when radon migrates through soil and rock into basements or is released indoors through domestic water use. This category covers indoor radon only, because outdoor concentrations are much lower.

Residual Public Health Risk

- Evaluated risks from direct inhalation of radon and exposure to radon through domestic water use.
- Ranked in highest category (5) for overall residual public health risk.
  - -- Ranked in category 5 for cancer risk because of large expected incidence of lung cancer cases
  - -- Ranked in category 2/1 for non-cancer risk

Residual Ecological Risk

- Not ranked. Considered to be primarily a public health risk.

Risk Management Factors

- Public Perception--Ranked 3 because the public has moderate concern about radon.
- Available Resources--Ranked 3 because funding is at approximately 50 percent of the workload model resource level.
- Economic Impact--Ranked 3 because costs are estimated at $69 million per year.
- Effective Technology--Ranked 4 because proven technology could greatly reduce the problem.
- Legal Authority--Ranked 1 because there are currently no laws applicable to radon.

5. Indoor Air Pollutants Other than Radon

Problem Area Definition

This problem area includes exposure to accumulated indoor air pollutants from sources in buildings. These sources include unvented space heaters and gas ranges, foam insulation, pesticides, tobacco (passive smoking), wood preservatives, fireplaces, cleaning solvents, and paints. The pollutants include tobacco smoke, carbon dioxide, pesticides, and numerous volatile organic chemicals, such as benzene and formaldehyde.

Residual Public Health Risk

- Carcinogens evaluated included tobacco smoke, chlordane, phthalate esters, formaldehyde, and heptachlor.
- Non-carcinogens evaluated included carbon monoxide, nitrogen oxides, respirable particulates, and formaldehyde.
- Acute and chronic non-cancer health effects evaluated included cardiac impairment and lung damage.
- Ranked in medium high category (4) for overall residual public health risk. Ranked in category 3 for both cancer risk and non-cancer risk.

Residual Ecological Risk

- Not ranked. Considered to be primarily a public health risk.

Risk Management Factors

- Public Perception--Ranked 3 because the public has moderate concern about this problem.
- Available Resources--Ranked 3 because regional funding (60 percent of the workload model) is considered inadequate by the Regional Program Manager.
- Economic Impact--Not ranked because sufficient cost information was not available.
- Effective Technology--Ranked 4 because proven technology could greatly reduce the problem.
- Legal Authority--Ranked 1 because there are currently no laws applicable to indoor air pollutants.

6. Radiation from Sources Other than Radon (Non-Ionizing)

Problem Area Definition

Nonoccupational exposure to non-ionizing radiation (beyond natural background) is included here. Non-ionizing radiation sources include high-voltage power lines, broadcast towers, and microwave and radar transmission. Recent evidence indicates possible association of such exposure with childhood leukemia, among other potential health effects. The work group considered only extremely low frequency (ELF) radiation and not radio-frequency radiation.

Residual Public Health Risk

- Evaluated the risks of ELF radiation exposure (radiation found in the vicinity of 60 Hz power sources) based on a study by Savitz, which demonstrates a possible association between electromagnetic fields and the incidence of childhood leukemia.
- Ranked in lowest category (1) for overall residual public health risk. Ranked in category 2 for cancer risk and category 2/1 for non-cancer risk based on a qualitative analysis and best professional judgment of the work group.

Residual Ecological Risk

- Not ranked. Considered to be primarily a public health risk.

Risk Management Factors

- Public Perception--Ranked 1 because the public is not concerned about this problem.
- Available Resources--Ranked 5 because program funding is considered adequate.
- Economic Impact--Ranked 5 because costs are estimated at $700,000 per year.
- Effective Technology--Ranked 4 because off-the-shelf technology is available.
- Legal Authority--Ranked 1 because there are currently no laws applicable to this problem.

7. Industrial Point Source Discharges to Surface Waters

Problem Area Definition

"Point sources are sources of pollution that discharge effluents into surface waters through discrete conveyances such as pipes or outfalls. Discharges result in contamination of surface waters and subsequent injury or harm to aquatic organisms, wildlife, and humans. Point sources have been divided for this project into industrial (this category) and POTW (Publicly Owned Treatment Works) sources (#8). Pollutants of concern include total suspended solids, BOD (Biological Oxygen Demand), toxic organics (e.g., phthalates and phenols), toxic inorganics (e.g., metals) and thermal pollution. Typical sources of discharge include chemical manufacturing, metal finishing, pulp and paper processing, and iron and steel production.

Residual Public Health Risk

- Evaluated with problem areas #8 and #9 (POTW and Nonpoint Source Discharges to Surface Waters). Evaluated exposure to PCBs, dioxin, lead, and mercury from ingestion of contaminated freshwater fish.
- Industrial point sources were considered to be the major contributor of contamination and were judged to pose higher risks than POTWs and Nonpoint Sources.
- Ranked in medium high category (4) for overall residual public health risk. Ranked in category 3 for cancer risk and category 4 for non-cancer risk.

Residual Ecological Risk

- Most significant sources of pollutants included metal finishers, pulp and paper processing, and textile dying operations.
- Ranked in highest category for ecological risk because of impacts on streams. Freshwater wetlands and estuaries are affected to a lesser extent.

Risk Management Factors

- Public Perception--Ranked 4 because the public has relatively high concern about this problem.
- Available Resources--Ranked 3 because regional funding (50 percent to 75 percent of the workload model) is considered inadequate by the Regional Program Manager.
- Economic Impact--Ranked 3 because control costs are estimated at $24.1 million per year.
- Effective Technology--Ranked 5 because off-the-shelf technology could greatly reduce the problem.
- Legal Authority--Ranked 5 because laws are considered adequate and enforced.

8. POTW Discharges to Surface Waters

Problem Area Definition

This problem area includes impacts from discharges to surface waters from municipal sewage treatment systems (Publicly Owned Treatment Works, or POTWs). These include industrial "indirect dischargers" connected to POTWs. Discharges result in contamination of surface waters and subsequent injury or harm to aquatic organisms, wildlife, and humans. Combined sewer overflows (CSOs) and stormwaters are included here also.

Residual Public Health Risk

- Evaluated with problem areas #7 and #9 (Industrial Point Source and Nonpoint Source Discharges to Surface Waters).
- Evaluated exposure to PCBs, dioxin, lead, and mercury from ingestion of contaminated freshwater fish.
- POTWs were judged to be a smaller contributor of contamination than industrial or nonpoint sources. Therefore, POTWs ranked relatively lower.
- Ranked medium low (2) for overall residual public health risk.
  - -- Ranked in category 2 for cancer risk
  - -- Ranked in category 2/1 for non-cancer risk

Residual Ecological Risk

- Considered the impacts of oxygen-demanding pollutants, toxics, and nutrients. Focused on streams and estuaries because most POTWs discharge into these ecosystems.
- Effects include the loss of aquatic resources from damage to fish and shellfish, and the reduced value of these waters as potential drinking water sources.
- Ranked in highest category for ecological risk because of impacts to estuaries and streams. Lower impacts were noted for lakes.

Risk Management Factors

- Public Perception--Ranked 3 because the public has moderate concern about this problem.
- Available Resources--Ranked 4 because regional funding is between 50 percent to 70 percent of the workload model.
- Economic Impact--Ranked 2 because control costs are estimated at $246 million per year.
- Effective Technology--Ranked 5 because off-the-shelf technology could greatly reduce the size of the current problem.
- Legal Authority--Ranked 5 because laws are considered adequate and enforced.

9. Nonpoint Source Discharges to Surface Waters

Problem Area Definition

This problem area includes exposures to pollutants that reach surface waters from nonpoint sources. These are sources other than discrete conveyances for effluents (such as in problem areas #7 and #8). This includes agricultural, urban, industrial, and silvicultural runoff; discharge of contaminated ground water; releases from contaminated in-place sediments; and air pollutant deposition into surface water. Discharges result in contamination of surface waters and subsequent injury or harm to aquatic organisms, wildlife, and humans.

Residual Public Health Risk

- Evaluated with problem areas #7 and #8 (Industrial Point Source and POTW Discharges to Surface Waters). Evaluated exposure to PCBs, dioxin, lead, and mercury from ingestion of contaminated freshwater fish.
- Nonpoint sources were judged to be a smaller contributor of contaminants than industrial sources. Therefore, nonpoint sources ranked relatively lower than industrial discharges.
- Ranked in medium category (3) for overall residual public health risk. Ranked in category 3 for cancer risk and category 2/1 for non-cancer risk.

Residual Ecological Risk

- Runoff from agriculture, urban areas, and land development are among the greatest ecological concerns. (Excluded from the analysis were on-site disposal systems, evaluated with Other Ground-Water Contamination, and hydro-modifications, evaluated with Wetlands/Habitat Loss.) Nutrients and sediments are the most significant stressors.
- Ranked in highest category for ecological risk because of impacts on lakes and streams.

Risk Management Factors

- Public Perception--Ranked 2 because the public has little concern about risks from nonpoint sources.
- Available Resources--Ranked 3 because regional funding (50 percent to 75 percent of the workload model) is considered inadequate by the Regional Program Manager.
- Economic Impact--Ranked 2 because control costs are estimated at $600 million per year.
- Effective Technology--Ranked 4 because off-the-shelf technology exists.
- Legal Authority--Ranked 3 because laws exist, although they have not been fully implemented.

10. Discharges to Estuaries, Coastal Waters, and Oceans from All Sources

Problem Area Definition

This problem area includes a wide variety of pollutants and sources that reach estuaries, coastal waters, and oceans and may result in contamination of seafood and subsequent exposure of humans. Specific sources can include ocean dumping of wastes, deposition of criteria and hazardous air pollutants, nonpoint runoff, dredge spoil disposal, and offshore drilling.

Residual Public Health Risk

- Evaluated exposure to 18 pollutants through ingestion of contaminated fish and shellfish.
- Ranked in medium category (3) for overall residual public health risk.
  - -- Ranked in category 3 for cancer risk based on cancer risk from fish ingestion (highest risks from PCBs and heptachlor)
  - -- Ranked in category 2/1 for non-cancer risk because none of the exposures to the pollutants evaluated exceeded RfDs

Residual Ecological Risk

- Not ranked as a problem area. Discharges to estuaries, coastal areas, and oceans were defined as two ecosystems (estuaries and marine) in the analysis.

Risk Management Factors

- Public Perception--Ranked 3 because the public has moderate concern about this problem.
- Available Resources--Ranked 4 because funding is at approximately 50 percent to 80 percent of the workload model.
- Economic Impact--Ranked 2 because control costs are estimated at $211 million per year.
- Effective Technology--Ranked 5 because off-the-shelf technology could greatly reduce the problem.
- Legal Authority--Ranked 4 because laws are considered adequate and implemented.

11. Wetlands/Habitat Loss

Problem Area Definition

This problem area includes all risks from pollutants reaching wetlands and uplands and impacts from physical alteration of wetlands and uplands. Activities that contribute to the problem include agricultural modification; flood control channelization; filling for highways, housing, and landfills; dredging for navigation channels, harbors, and marinas; mining and resource extraction; discharges from point and nonpoint sources, and others, including contamination from hazardous waste sites. Such activities alter the salinity and water level while contributing turbidity, sedimentation, and numerous pollutants. The more significant overriding impact is the continued loss of habitat through the elimination of both wetlands and adjacent uplands.

Residual Public Health Risk

- Not ranked. Considered to be primarily an ecological risk.

Residual Ecological Risk

- Considered risks from destruction, conversion, and pollution of wetlands and habitat areas. Highest risk is in rapidly growing areas of New England.
- Ranked in highest category for ecological risk because of impacts associated with the loss of upland areas, streams, freshwater wetlands, and agricultural areas as habitat environments and breeding areas.

Risk Management Factors

- Public Perception--Ranked 2 because the public has little concern about this problem.
- Available Resources--Ranked 2 because regional funding is approximately 20 percent of the workload model, including resources shifted into the program.
- Economic Impact--Not ranked because sufficient cost information was not available.
- Effective Technology--Ranked 3 because off-the-shelf technology exists but is not fully efficient.
- Legal Authority--Ranked 2 because laws are considered inadequate.

12. Drinking Water

Problem Area Definition

This problem area includes exposures to contaminants found in drinking water as it arrives at the tap. These contaminants may derive from both natural and man-made sources. Surface and ground-water drinking water supplies are included. Radon and lead are excluded from this analysis as they are covered in problem areas #4 and #22. Pollutants of concern include pathogens, disinfectant byproducts, and naturally occurring compounds such as fluoride, arsenic, and radium.

Residual Public Health Risk

- Evaluated ingestion of pollutants in drinking water based on monitoring data and maximum contaminant level (MCL) violations. Also considered the effects of inhalation and dermal absorption of pollutants.
- Ranked in medium high category (4) for overall residual public health risk. Ranked in category 3 for both cancer and non-cancer risk, based on ingestion of carcinogens and non-carcinogens.

Residual Ecological Risk

- Not ranked. Considered primarily a public health risk.

Risk Management Factors

- Public Perception--Ranked 5 because the public is very concerned about this problem.
- Available Resources--Ranked 2 because regional funding is approximately 35 percent to 75 percent of the workload model, including resources shifted into this problem area.
- Economic Impact--Ranked 3 because control costs are estimated at $87.8 million per year.
- Effective Technology--Ranked 4 because off-the-shelf technology exists.
- Legal Authority--Ranked 3 because laws exist, although they are not fully implemented.

13. RCRA Waste Sites

Problem Area Definition

This category includes the risks posed by hazardous waste sites regulated under the Resource Conservation and Recovery Act (RCRA). More specifically, it includes operating and inactive RCRA landfills and surface impoundments, hazardous waste storage tanks, hazardous waste burned in boilers and furnaces, hazardous waste incinerators, and associated solid waste management units. Seepage and routine releases from these sources contaminate soil, surface water, and ground water, and pollute the air.

Residual Public Health Risk

- Estimated risks from treatment, storage, and disposal of RCRA wastes based on modeled release and exposure pathways.
- Ranked in lowest category (1) for overall residual public health risk.
  - -- Ranked in category 2 for cancer risk, primarily due to risks from hazardous waste incinerators
  - -- Ranked in category 2/1 for non-cancer risk because exposures to all pollutants evaluated were lower than the RfDs
- Ranking did not include risks from blending and burning of used oil. Solid Waste Management Units (SWMUs) were considered, but more detailed information could raise the risk estimate.

Residual Ecological Risk

- Evaluated modeled releases from RCRA units to air, ground water, and surface water.
- Greatest concern associated with the RCRA units were welfare impacts caused by degradation of ground water.
- Ranked in medium category for ecological risks because of impacts on tidal wetlands, freshwater wetlands, and streams.

Risk Management Factors

- Public Perception--Ranked 4 because the public has relatively high concern about RCRA facilities.
- Available Resources--Ranked 2 because regional funding is approximately 10 percent of the workload model.
- Economic Impact--Ranked 3 because control costs are estimated at $67.4 million per year.
- Effective Technology--Ranked 4 because proven technology could greatly reduce the problem.
- Legal Authority--Ranked 4 because laws are adequate and implemented.

14. Superfund Waste Sites

Problem Area Definition

This category includes hazardous waste disposal sites that are regulated by Superfund. Generally, they are inactive and abandoned sites. They can include sites on the National Priorities List (NPL), those deleted from the NPL, those that are candidates for the NPL, and any additional sites that states may be addressing. Releases from these sites contaminate soil, surface water, ground water, and air.

Residual Public Health Risk

- Evaluated "Endangerment Assessments" from 13 Superfund sites. Extrapolated data on pollutants and average exposures to the Region as a whole.
- Ranked in lowest category (1) for overall residual public health risks.
  - -- Ranked in category 2 for cancer risk, based on low exposures to carcinogens
  - -- Ranked in category 2/1 for non-cancer risk because pollutants evaluated generally did not exceed the RfDs

Residual Ecological Risk

- Qualitatively evaluated impacts based on proximity of Superfund sites to streams and freshwater wetlands.
- Greatest concern associated with Superfund sites was welfare impacts caused by degradation of ground water.
- Ranked in medium category for ecological risk because of impacts to streams and freshwater wetlands.

Risk Management Factors

- Public Perception--Ranked 5 because the public is very concerned about this problem.
- Available Resources--Ranked 4 because regional funding (90 percent of the workload model) is considered inadequate by the Regional Program Manager.
- Economic Impact--Ranked 2 because control costs are estimated at $230 million per year.
- Effective Technology--Ranked 3 because proven technology exists.
- Legal Authority--Ranked 3 because laws exist, although they have not been fully implemented.

15. Municipal Waste Sites

Problem Area Definition

This problem area includes exposures to releases from open and closed municipal landfills, municipal sludge and waste incinerators, municipal surface impoundments, land application units, and land treatment units. Impacts from the management (disposal, treatment, and reuse) of all household, municipal, and other solid waste not regulated by RCRA are included here. Routine and non-routine releases, soil migration, and runoff can contribute particulates, toxics, BOD, PCBs, and nutrients to air, soil, and surface and ground water.

Residual Public Health Risk

- Evaluated exposure to drinking water contaminated by leachate from municipal landfills.
- Ranked in lowest category (1) for overall residual public health risk.
  - -- Ranked in category 2 for cancer risk, based on low estimate of cancer incidence
  - -- Ranked in category 2/1 for non-cancer risk because pollutants evaluated generally did not exceed the RfDs

Residual Ecological Risk

- Evaluated with problem area #16 (Industrial Waste Sites). Sufficient data were not available to evaluate all impacts. Greatest concern is potential contamination of ground water by leachate and associated welfare impacts. Location of landfills in proximity to wetlands may pose a risk.
- Ranked in medium category for ecological risk because of impacts of toxics discharged from leachate to freshwater wetlands.

Risk Management Factors

- Public Perception--Ranked 3 because the public has moderate concern about this problem.
- Available Resources--Ranked 1 because Region I has had little or no funding in the past.
- Economic Impact--Ranked 2 because control costs are estimated at $133 million per year.
- Effective Technology--Ranked 4 because proven technology could greatly reduce the problem.
- Legal Authority--Ranked 2 because laws are considered inadequate.

16. Industrial Waste Sites

Problem Area Definition

This category includes industrial waste, including sludges handled in nonhazardous industrial landfills, industrial surface impoundments, land application units, and land treatment units subject to Subtitle D, along with numerous incinerators. Routine and nonroutine releases, soil migration, and runoff may contribute particulates, toxics, BOD, PCBs, and nutrients to air, surface water, ground water, and soil.

Residual Public Health Risk

- Risks from industrial waste sites were compared with those from municipal waste sites, without additional data on industrial sites. Assumed contaminants are similar to those released from municipal sites, but concentrations at industrial sites are presumed to be higher.
- Ranked in lowest category (1) for residual public health risk. Ranked in category 2 for cancer risk and category 2/1 for non-cancer risk.

Residual Ecological Risk

- Evaluated with problem area #15 (Municipal Waste Sites). Sufficient data were not available to evaluate all impacts.
- Greatest concern is potential contamination of ground water by leachate and associated welfare impacts. Location of sites in proximity to wetlands may pose a risk.
- Ranked in medium category for ecological risk because of impacts on freshwater wetlands.

Risk Management Factors

- Public Perception--Ranked 3 because the public has moderate concern about this problem area.
- Available Resources--Ranked 1 because Region I has had little or no funding in the past.
- Economic Impact--Ranked 3 because control costs are estimated at $10 million per year.
- Effective Technology--Ranked 4 because proven technology could greatly reduce the problem.
- Legal Authority--Ranked 2 because laws are considered inadequate.

17. Accidental Releases

Problem Area Definition

Contaminants are accidentally released into the environment in a variety of ways during storage, transport, or production. Damages to industrial property and personnel and releases to sewers, oceans, air, soil, and water may occur from substantial, though short-term, releases of a variety of chemicals, some highly toxic or flammable. Acids, PCBs, ammonia, and sodium hydroxide are examples of such releases, with PCB accidents being the most frequent. Catastrophic events requiring emergency response are included here. Releases from oil spills are also included in this category, with a focus on water releases where the impacts are often the most severe. Spilled products may include pesticides, crude oil, gasoline, solvents, diesel oil, fuel oil, and other distillates. Spills from tanks are included in problem area #18.

Residual Public Health Risk

- Used data from reported accidents. Focused on inhalation exposure routes; dermal and ingestion routes were considered secondary. Risks are assumed to be primarily non-cancer-related because cancer risks associated with single-episode releases are considered unlikely.
- Ranked in medium low category (2) for overall public health risk. Ranked in category 1 for cancer risk and ranked in category 3 for non-cancer risk.

Residual Ecological Risk

- Used data from reported accidents to estimate the total number of accidental releases. Focused on releases affecting surface water because data on terrestrial impacts were not available.
- Ranked in highest category for ecological risk based on potential impacts on estuaries, tidal wetlands, and marine ecosystems from a major oil spill.

Risk Management Factors

- Public Perception--Ranked 4 because the public has relatively high concern about accidental releases.
- Available Resources--Ranked 3 because regional funding is approximately 50 percent of the workload model.
- Economic Impact--Ranked 4 because control costs are estimated at $4.5 million per year.
- Effective Technology--Ranked 3 because off-the-shelf technology exists, but is not fully efficient.
- Legal Authority--Ranked 5 because laws are adequate and enforced.

18. Releases from Storage Tanks

Problem Area Definition

This category includes releases of petroleum products or other chemicals from tanks that are above, on, or underground; tanks owned by farmers; and the fuel oil tanks of homeowners. Stored products include motor fuels, heating oils, solvents, pesticides, lubricants, and other chemical compounds or miscellaneous substances that can contaminate ground water with such toxics as benzene, toluene, and xylene. Storage of hazardous waste in tanks is included in problem area #13 (RCRA Waste Sites).

Residual Public Health Risk

- Focused on health effects from inhalation of pollutants from petroleum releases. Data were insufficient to quantitatively evaluate the cancer or non-cancer risk. Estimated numbers of contaminated wells and the subsequent number of people exposed through inhalation to contaminants.

- Ranked in medium low category (2) for overall public health risk. Ranked in category 2 for cancer risk and category 3 for non-cancer risk based on qualitative judgment of risks relative to other problem areas.

Residual Ecological Risk

- Primary concerns associated with releases from storage tanks include contamination of surface waters from runoff, contaminated ground water and its discharge to surface water, contamination of soil, and evaporation of pollutants into the air.

- Ranked in medium category for ecological risk based on impacts to fresh water wetlands. Degradation of ground water may have welfare impacts.

Risk Management Factors

- Public Perception--Ranked 3 because the public has moderate concern about this problem.

- Available Resources--Ranked 4 because funding is considered adequate by the Regional Program Manager.

- Economic Impact--Ranked 2 because control costs are estimated at $520 million per year.

- Effective Technology--Ranked 4 because off-the-shelf technology exists.

- Legal Authority--Ranked 3 because laws exist, although they are not fully applicable.

19. Other Ground-Water Contamination

Problem Area Definition

A variety of point and nonpoint sources of pollution not counted in other categories for this analysis also contaminate ground water. These include leaching of fertilizers, pesticides, septic systems, road salt, class V injection wells, nonwaste material stockpiles, pipelines, and irrigation practices. This category excludes impacts from tanks and hazardous waste sites. The list of possible contaminants is extensive and includes nitrates, microbes, sodium, chloride, pesticides, toxic organics and inorganics, oil and petroleum products.

Residual Public Health Risk

- Considered risks associated with contamination from septic systems, road de-icing salts, class V underground injection wells, and leaching of agricultural pesticides and fertilizers. Evaluated ingestion of contaminated ground water from private drinking water supplies. (Public water supply contamination was evaluated under the Drinking Water problem area.)

- Greatest risk was associated with bacterial and viral contamination from septic tanks and cesspools.

- Ranked in medium high category (4) for overall residual public health risk.

  -- Ranked in category 2 for cancer risk

  -- Ranked in category 4 for non-cancer risk, based on estimates of risk of hepatitis and gastrointestinal disease from ground-water contamination of drinking water

Residual Ecological Risk

- Greatest ecological risk associated with ground-water contamination is through discharge to surface waters. Primary concern with contamination of ground water is the potential loss of drinking water resources for humans.

- Ranked medium for ecological risk because of impacts on lakes, estuaries, streams, and freshwater wetlands.

Risk Management Factors

- Public Perception--Ranked 3 because the public has moderate concern about this problem.

- Available Resources--Ranked 2 because regional funding is approximately 28 percent to 45 percent of the workload model, including resource shifts into the program.

- Economic Impact--Not ranked because no cost data were identified.

- Effective Technology--Ranked 3 because proven technology is available.

- Legal Authority--Ranked 3 because laws exist, although they are not fully adequate in areas such as nonpoint source contamination.

20. Pesticide Residues on Foods

Problem Area Definition

Humans, wildlife, and other animals are directly exposed to pesticides through residues on or in food (e.g., plants, meat, seeds, and insects). Pesticides are defined to include insecticides, herbicides, fungicides, and rodenticides. Certain pesticides bioaccumulate and enter food chains. Residues from proper as well as improper application are included. Exposure to residues on foods imported into Region I, as well as on foods grown in the Region, are included. Risks from pesticides prior to exposure through food are included in problem area #21.

Residual Public Health Risk

- Apportioned the national risk estimated in NCRP to Region I based on the Regional population. Considered ingestion of food both locally grown and imported into the region.
- Ranked in medium high category (4) for residual public health risk, based on the high estimate of expected cancer cases.
  - -- Ranked in category 4 for cancer risk
  - -- Ranked in category 2/1 for non-cancer risk, because non-cancer estimate was low

Residual Ecological Risk

- Evaluated with Problem Area #21 (Pesticide Application). Considered risks from direct application of pesticides to ecosystems and resultant residues on foods consumed by wildlife.
- Lakes, freshwater wetlands, terrestrial ecosystems considered at risk through direct applications and through infiltration from other locations as a result of drift and runoff.
- Ranked in medium category for ecological risk because of risks to lakes, fresh water wetlands, and terrestrial ecosystems. Agricultural risks were not evaluated. Potential for ground-water contamination was considered high.

Risk Management Factors

- Public Perception--Ranked 2 because the public has little concern about this problem.
- Available Resources--Ranked 3 because funding for all pesticide problems (pesticide application and residues) is estimated at 25 percent to 50 percent of the workload model.
- Economic Impact--Ranked 4 because control costs are estimated at $2.6 million to $4.3 million per year.
- Effective Technology--Ranked 4 because off-the-shelf technology exists.
- Legal Authority--Ranked 4 because laws considered adequate and implemented.

21. Pesticide Application

Problem Area Definition

This category includes exposure of commercial and private pesticide applicators, including farm workers who mix, load, and apply pesticides. Risk from proper and improper application are included. Risks from accidental exposure of people and wildlife during application and impacts on ecosystems are also included.

Residual Public Health Risk

- Apportioned the national risk estimate from NCRP to Region I based on regional pesticide use. Non-cancer risk assessment focused on inhalation and direct contact for applicators and farm workers. Considered hospital admissions and respiratory problems using a national pesticide poisoning incidence rate.
- Ranked in medium low category (2) for overall residual public health risk.
  - -- Ranked in category 2 for cancer risk, based on low estimate of cancer cases in the region
  - -- Ranked in category 3 for non-cancer risk based on qualitative assessment

Residual Ecological Risk

- Evaluated with Problem Area #20 (Pesticide Residues on Food). Considered risks from direct application of pesticides to ecosystems and resultant residues on foods consumed by wildlife.
- Lakes, freshwater wetlands, terrestrial ecosystems considered at risk from direct applications and through infiltration from other locations as result of drift and runoff.
- Ranked in medium category for ecological risk because of risks to lakes, fresh water wetlands, and terrestrial ecosystems. Agricultural risks were not evaluated. Potential for ground-water contamination was considered high.

Risk Management Factors

- Public Perception--Ranked 2 because the public has little concern about this problem.
- Available Resources--Ranked 3 because funding for all pesticide problems (pesticide application and residues) is estimated at 25 percent to 50 percent of the workload model.
- Economic Impact--Ranked 4 because control costs are estimated at $125 million to 500 million per year. (This may overestimate costs based on the amount of agricultural areas in the Region.)
- Effective Technology--Ranked 4 because proven technology could greatly reduce the problem.
- Legal Authority--Ranked 4 because laws are considered adequate and implemented.

22. Lead

Problem Area Definition

This category includes the risks from exposure to lead in soil, drinking water, and air.

Residual Public Health Risk

- Evaluated exposure from ingestion of paint, soil, and drinking water, and exposure from inhalation of contaminated air and dust. Used data on lead poisoning in children under six years of age. Lead poisoning was defined as a blood lead level greater than 25 ug/dl. Learning disabilities were the driving health endpoint. Cancer risks were not evaluated, because lead is not currently considered a carcinogen.
- Ranked in highest category (5) for overall residual public health risk.
  - -- Ranked in category 1 for cancer risk
  - -- Ranked in category 5 for non-cancer risk due to large number of children estimated to have lead poisoning

Residual Ecological Risk

- Not ranked. Lead exposure to ecosystems was included in problem areas addressing point and non-point source discharges to surface waters (#7, #8, and #9).

Risk Management Factors

- Public Perception--Ranked in category 3 because the public has moderate concern about lead poisoning.
- Available Resources--Ranked in category 3 because average value for funding of lead in soil, drinking water, and air programs is less than 50 percent of the workload model.
- Economic Impact--Ranked in category 1 because costs to control lead in all media are estimated at $1.26 billion per year.
- Effective Technology--Ranked 4 because off-the-shelf technology is available to control lead in the air, and proven technology could greatly reduce lead in water and soil.
- Legal Authority--Ranked 3 because laws to control lead in air and water exist, although authority to control lead in soil is not considered adequate.

23. Asbestos

Problem Area Definition

This problem area includes risks from inhalation of asbestos in ambient air.

Residual Public Health Risk

- Evaluated non-occupational exposures and rural and urban ambient exposures. Considered inhalation of asbestos and the associated risks of lung cancer, mesothelioma, and gastrointestinal cancer. Non-cancer health effects (asbestosis and lung damage) were not estimated.
- Ranked in medium category (3) for residual public health risk.
  - -- Ranked in category 3 for cancer risk
  - -- Ranked in category 2/1 for non-cancer risk

Residual Ecological Risk

- Not ranked. Considered primarily a public health risk.

Risk Management Factors

- Public Perception--Ranked 4 because the public has relatively high concern about this problem.
- Available Resources--Ranked 3 because regional funding (50 percent to 75 percent of the workload model) is considered inadequate by the Regional Program Manager.
- Economic Impact--Ranked 2 because control costs are estimated at $115 million per year.
- Effective Technology--Ranked 5 because off-the-shelf technology could greatly reduce the problem of asbestos in air and water.
- Legal Authority--Ranked 5 because laws are adequate and enforced.

24. Lakes, Ponds, and Impoundments

Problem Area Definition

Lakes, ponds, and impoundments are recipients of the same variety and sources of pollutants as surface waters and estuaries, but react more acutely to very low level contamination. Pollution of lakes may result in injury or contamination of aquatic life, as well as subsequent exposure to wildlife and human consumers. Eutrophication and/or dominance of nuisance aquatic organisms are sometimes dealt with through the application of herbicides or larvicides that add to a lake's chemical contamination. If left unchecked, dominance of nuisance plants or animals will severely restrict the recreational benefits of these water bodies.

Residual Public Health Risk

- Not ranked. Health risks were evaluated under problem areas addressing discharges to surface waters (#7, #8, and #9).

Residual Ecological Risk

- Not ranked. Defined as an ecosystem in the work group analysis.

Risk Management Factors

- Public Perception--Ranked 2 because the public has little concern about this problem.
- Available Resources--Ranked 3 because regional funding is considered to be approximately 50 percent of the workload model.
- Economic Impact--Not ranked because cost data were unavailable. Costs are estimated to be low.
- Effective Technology--Ranked 5 because off-the-shelf technology exists and could greatly reduce the problem.
- Legal Authority--Ranked 3 because laws exist, although they are not fully implemented.

Key
Risk Management Factors

Public Perception

Public does not perceive problem	Public perceives problem as serious
1 ----------	5

Available Resources

No EPA resources to address problem area	Adequate EPA resources to address problem area
1 ----------	5

Economic Impact

High economic impact	Low economic impact
1 ----------	5

Effective Technology

No available, effective technology	Easily available, effective technology
1 ----------	5

Legal Authority

No applicable federal, state, or local statutes	Applicable federal, state, and local statutes and case law
1 ----------	5